

ODB++ Design Format Specification

Release 8.1 Update 2

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Chapter 1

ODB++ Design Format Specification

Competing in global markets requires PCB design organizations to continually seek ways to more effectively communicate their product definition data to fabrication, assembly and test organizations.

The goal is to simultaneously maximize three aspects:

- Speed in transferring a new product design into the manufacturing process
- Accuracy of communication of the designer's intentions to the manufacturer
- Opportunities for reduction in total manufacturing cost

All the data transferred to manufacturers by a designer that defines the PCB for the purposes of bare board fabrication, assembly and test can be referred to as the manufacturing product model. To the manufacturer, this product model defines “what” should be manufactured and delivered back to the product owner. The manufacturer's task is to validate the manufacturability of the product, then derive and execute the optimal manufacturing process for its manufacture.

The ODB++ Design data exchange format is the most widely accepted, integrated product model format for efficiently handing off a PCB from design into manufacturing. The ODB++ Design format is a simple yet comprehensive description of all entities necessary to answer the question of “what” needs to be manufactured, covering fabrication, assembly and test of a PCB.

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Changes to the ODB++ Design Format Since V8.0

Changes have been made to the ODB++ Design format in V8.0 and since V8.0.

ODB++ Design 8.1 Update 2

These changes were implemented in this version:

- The ODB++ format has been renamed to ODB++ Design. The specification title has been adapted according to the new format name. Other occurrences in the specification refer to the format name as ODB++ Design or ODB++.
- The optional file *impedance.xml* (impedance file) can be added to the `<step_name>` directory. This file contains data relevant to the calculation of copper impedance.

See “[<step_name>/impedance.xml \(Impedance\)](#)” on page 132.

- The contents of the attribute definition files *sysattr*, *sysattr.dfm*, *sysattr.fab*, and *sysattr.assy* have been reorganized to ensure more accurate classification.
 - See “[Product \(sysattr\)](#)” on page 271.
 - See “[DFM \(sysattr.dfm\)](#)” on page 276.
 - See “[Fabrication \(sysattr.fab\)](#)” on page 279.
 - See “[Assembly \(sysattr.assy\)](#)” on page 281.
- Added product attribute (sysattr) `.rout_plated`.
 - See “[ODB++ System Attributes - Alphabetical List](#)” on page 215.
- These impedance attributes were added as product attributes (sysattr):
`.eda_define_imp_line`, `.imp_constraint_id`, `.imp_polyline_id`, `.impedance_test_width`, `.padstack_id`, `.soldermask_define_no_edits`.

- See “[ODB++ System Attributes - Alphabetical List](#)” on page 215.
- Product attributes (sysattr) .ipc_via_type_top and .ipc_via_type_bottom were added to support the IPC-4761 Via types.
 - See “[ODB++ System Attributes - Alphabetical List](#)” on page 215.
- Product attribute (sysattr) .via_in_pad was added to support Via in Pad (VIP).
 - See “[ODB++ System Attributes - Alphabetical List](#)” on page 215.
- The optional file *stackup.xml* (stackup file) can be added to the `<product_model_name>/matrix` directory.

The stackup file will replace the matrix file in the next major release of the ODB++ format. In the meantime, the matrix file is required and the stackup file is optional. The format will rely on the matrix file as the primary source of data. If there is an inconsistency, the matrix file will be the primary source of matrix-related ODB++ content.

See “[matrix/stackup.xml \(Stackup\)](#)” on page 52.

ODB++ 8.1 Update 1

These changes were implemented in this version:

- The manual was fixed to specify the correct formula used to round the line ends for a line thermal symbol.

See “[Basic Standard Symbols](#)” on page 195.
- ODB++ now supports HDI netlists.

See “[eda/hdi_netlist \(HDI Netlist\)](#)” on page 126.
- ODB++ now supports layers containing wire bond information.

See “[Layer Subtypes](#)” on page 70.
- ODB++ now supports dimensions.

See “[<layer_name>/dimensions \(Dimensions\)](#)” on page 161.
- The manual was fixed to remove an extraneous semicolon from the syntax of the barcode record of the `<layer_name>/features` entity.

See “[B — Barcode Records](#)” on page 183.
- The manual was fixed to specify the correct limits for measurements such as coordinates and distances. The Cartesian coordinates supported are within the range of (-100, -100) to (100, 100) inches, which is (-2450, -2450) to (2450, 2450) mm.

See “[Units of Measurement](#)” on page 23.

ODB++ 8.1

These changes were implemented in this version:

- Metadata has been added to the ODB++ format.
See “[misc/metadata.xml \(Metadata\)](#)” on page 79.
- A *shorts* file has been added to the ODB++ format for defining a list of features that are known to create intentional net shorts within the product model.
See “[eda/shorts \(Electrical Intention Short Net\)](#)” on page 120.
- A *zones* file has been added to the ODB++ format for defining regions of the board where the board layer materials, including the layer types, are identical.
See “[<step_name>/zones \(Matrix Broken Into Sections\)](#)” on page 145.
- This manual has been reorganized to more closely reflect the ODB++ directory structure:
 - *misc/sysattr.** section moved from the Basic Principles chapter to the misc directory description.
See “[misc/sysattr.* \(Attribute Definition\)](#)” on page 86.
 - *misc/userattr* section added to the misc directory description.
See “[misc/userattr \(User Attribute Definition\)](#)” on page 92.
 - A discussion of attribute value assignment was added - using an *attrlist* file or using lookup tables in a file defining features, components, or nets.
See “[Attribute Value Assignment](#)” on page 28.
- Additional supported fields are available for the LAYER array of the matrix file.
See “[Fields in the LAYER Array of a Matrix File](#)” on page 65.

ODB++ 8.0 Update 6

These changes were implemented in this version:

- Section on layer types to support embedded resistors and capacitors added in Product Model Entities.
See “[Layer Subtypes](#)” on page 70.
- Added test attributes *.net_test_type*, *.net_test_current*, *.net_test_voltage*.
 - See “[ODB++ System Attributes - Alphabetical List](#)” on page 215.
 - See “[Test \(sysattr.test\)](#)” on page 283.

- Added amps (for current) and volts (for voltage) to the table of units in which data can be stored.

See “[Units of Measurement](#)” on page 23.

- Added options CURRENT and VOLTAGE to possible options for UNIT_TYPE parameter of an attribute of type FLOAT.

See “[FLOAT Attribute Definition](#)” on page 90.

- Updated the table How the UNITS Directive Determines Units of Measurement, to eliminate ambiguity.

See “[Units of Measurement](#)” on page 23.

ODB++ 8.0 Update 5

These changes were implemented in this version:

- Maximum value for .z0impedance changed from 0.5 to 10000.
See “[ODB++ System Attributes - Alphabetical List](#)” on page 215.
- Definition of the side parameter in netlist file format has been further clarified.
See “[cadnet/netlist \(cadnet\)](#)” on page 135.
- A comment was added to the effect that surfaces must have at least one polygon defined.
See “[S — Surface Records](#)” on page 185.
- The description of unique IDs was clarified.
See “[Unique ID](#)” on page 30.
- Explanation of record type F (number of features) added to the description of the features file.
See “[<layer_name>/features \(Graphic Features\)](#)” on page 170.

ODB++ 8.0 Update 4

These changes were implemented in this version:

- Parameter descriptions for comp_num and toep_num corrected, and clarification added to fill_size for toepint section.
See “[SNT— Subnet Record](#)” on page 115.
- Clarification of layer profile use when a step profile hole is found within or intersecting a layer profile island.
See “[<layer_name>/profile \(Outline Shape of Layer\)](#)” on page 188.

- Clarification of the relationship between records PKG and CMP.
See “[PKG — Package Record](#)” on page 116 and “[CMP — Component Record](#)” on page 157
- Section on Angles added to Basic Principles section to relate to the angle definition in Step and Repeat records and the orient_def field in Pad records, Text records, and Barcode records.
See “[Angles](#)” on page 34.
- DSC parameter in BOM Description Records corrected from ‘up to 5’ to ‘unlimited’.
See “[BOM Description Records](#)” on page 158.
- Clarification of what constitutes a legal net name.
See the description of \$<serial_num> <net_name> in “[cadnet/netlist \(cadnet\)](#)” on page 135 and <net_name> in “[NET — Electrical Net Record](#)” on page 114.

ODB++ 8.0 Update 3

These changes were implemented in this version:

- UNIT_TYPE of RESISTIVITY requires a UNITS value.
- Two new UNITS values available when UNIT_TYPE=RESISTIVITY—OHM and NANO_OHM.
See “[FLOAT Attribute Definition](#)” on page 90.
- UNITS value NANO_OHM added to system attribute .bulk_resistivity.
- COPPER_WEIGHT added to the list of available UNIT_TYPE values.
See “[FLOAT Attribute Definition](#)” on page 90.
- In the cadnet/netlist (cadnet) step entity, the definition of the radius field was expanded.
See “[cadnet/netlist \(cadnet\)](#)” on page 135.
- Two product attributes (sysattr) .centroid_correction_x and .centroid_correction_y added.
See “[ODB++ System Attributes - Alphabetical List](#)” on page 215.

- These attributes have been updated to include the required **UNITS** tag, in the relevant sysattr file:

sysattr	sysattr.assy	sysattr.dfm	sysattr.fab
.board_thickness .bulk_resistivity .comp_height .comp_height_max .comp_htol_minus .comp_htol_plus .layer_dielectric .pitch .testprobe_diameter .thickness_over_cu .thickness_over_sm	.spo_h_val .spo_move_center .spo_p_val .spo_s_val .spo_w_val	.ar_pad_drill_bottom_max .ar_pad_drill_bottom_min .ar_pad_drill_inner_max .ar_pad_drill_inner_min .ar_pad_drill_top_max .ar_pad_drill_top_min .ar_sm_drill_bottom_max .ar_sm_drill_bottom_min .ar_sm_drill_top_max .ar_sm_drill_top_min .ar_sm_pad_bottom_max .ar_sm_pad_bottom_min .ar_sm_pad_top_max .ar_sm_pad_top_min .dpair_gap .drc_max_height .drc_min_height .eclass_max_stub_length .eclass_min_stub_length .local_fiducial_dist .min_line_width .net_length_max .net_length_min .toep_spacing_req	.et_adjacency .fill_dx .fill_dy .image_dx .image_dy

For a description of each attribute, see “[ODB++ System Attributes - Alphabetical List](#)” on page 215.

ODB++ 8.0 Update 2

These changes were implemented in this version:

- Improved the netlist example to include the use of ‘ld’.
See “[cadnet/netlist \(cadnet\)](#)” on page 135.
- Corrected the syntax for the optimization (H) record.
See “[cadnet/netlist \(cadnet\)](#)” on page 135.
- Tools (Drill Tools):
 - Corrected to indicate units of measurement for MIN_TOL, MAX_TOL, FINISH_SIZE and DRILL_SIZE.

- Added in the description of FINISH_SIZE that if this value is not set, the value should be -1.

See “[<layer_name>/tools \(Drill Tools\)](#)” on page 191.

- Clarified that the decimal character is required to be a period, and no other representation of numbers (scientific or exponential) is allowed.

See “[Coordinates](#)” on page 34.

- Clarified that the decimal character is required to be a period.

See “[Symbols](#)” on page 36.

- The compression attribute was added to *bom*, and the example was modified.

See “[<bom_name>/bom \(Bill Of Materials\)](#)” on page 101.

- More detailed descriptions were added to the START_NAME and END_NAME fields in the LAYER array of the matrix file.

See “[Fields in the LAYER Array of a Matrix File](#)” on page 65.

ODB++ 8.0 Update 1

These changes were implemented in this version:

- Default color for layer display in the layer list is 0, indicating no preference.
See the COLOR field in “[Fields in the LAYER Array of a Matrix File](#)” on page 65.
- Netlist definition enhanced to include staggered.
See the example for “[cadnet/netlist \(cadnet\)](#)” on page 135.
- Corrected format syntax.
See “[NET — Electrical Net Record](#)” on page 114.
- SNT VIA and SNT TRC records were clarified to not contain any additional parameters.
See “[SNT— Subnet Record](#)” on page 115.
- PKG—Package Record — Corrected format syntax.
See “[PKG — Package Record](#)” on page 116.
- PIN—Pin Record — Clarified the determination of pin #1.
See “[PIN — Pin Record](#)” on page 117.

ODB++ 8.0

These changes were implemented in this version:

- Attributes are divided according to area: DFM, Product, or Process. The Process attributes are further classified as Fab, Assem, Test, or Generic.

See “[ODB++ Attributes](#)” on page 27.

- Includes Flex and Flex-rigid PCB modeling.

See “[Layer Subtypes](#)” on page 70.

- Symbols added for Solder Stencil Design:

- Home Plate
- Inverted Home Plate
- Flat Home Plate
- Radiused Inverted Home Plate
- Radiused Home Plate
- Cross
- Dogbone
- D-Pack

See “[Symbols Suitable for Solder Stencil Design](#)” on page 210.

- Default metric/imperial measurement used throughout product model definition. The units directive UNITS=MM|INCH can be added at the beginning of any file that contains measurable entities.

See “[Units of Measurement](#)” on page 23.

- Drill span direction.
- Creation of profile with holes enabled.
- Net name length enlarged. There is no limit on the number of characters in a net name.
- Support for test probes. Test Probe Diameter attribute introduced to provide information on the size of test probes.
- PCB build up information stored in product model.
- Support for increased number of BOM Desc attributes. Number of descriptions in BOM (DESC<index> or PART_DESC<index>) is unlimited.
- Introduction of package attributes.

- It is now possible to implement component Bill of Material (BOM) information within the component file.

File System

The ODB++ format uses a standard file system structure. A product model stored in the ODB++ format is represented by an independent and self-contained directory tree. This provides the ability to transfer the product model from design systems into manufacturing systems in an efficient manner, without any loss of information.

The advantages of a directory tree, compared to one large file, are apparent when a product model is being read from disk or saved to disk. The flexible tree structure allows you to read or save exactly the required part of the product model, avoiding the overhead of reading and writing a large file, if only a subset of the information is required.

When a product model tree must be transferred to another system, standard tar and compression utilities can be used to convert a directory tree into a single flat file.

These files and directories are mandatory. Other files and directories discussed in this document are included only when needed.

- *<product_model_name>/matrix/matrix*
- *<product_model_name>/misc/info*
- *<product_model_name>/fonts/standard*
- *<product_model_name>/steps/<step_name>/stephdr*
- *<product_model_name>/steps/<step_name>/layers/<layer_name>/features (or features.Z)*

There are links between files, defined implicitly in the ODB++ definition, that create dependencies between files.

For example, the file */<step_name>/layers/comp_+_top/components* contains links to */<step_name>/eda/data*, and the */<step_name>/layers/<layer_name>/features* file contains links to user-defined symbols located in *<product_model_name>/symbols*.

Legal Entity Names

The names of these ODB++ entities must comply with the rules for legal entity names: product model, step, layer, symbol, and attribute.

- The length of an entity name must not exceed 64 characters.

- An entity name may contain only these characters:
 - Lower case letters (a through z).
 - Digits (0 through 9).
 - Punctuation—dash (-), underscore (_), dot (.) and plus (+).
- Entity names must not start with a dot (.), hyphen (-), or plus (+).

The exception is system attribute names, which start with a dot. Names of user-defined attributes must not start with a dot.

- Entity names must not end with a dot (.).

Units of Measurement

ODB++ files can contain an indication of the units of measurement used in the file.

Unlike traditional CAM formats such as Gerber, ODB++ format represents a complete product model rather than a collection of unrelated geometric entities. All ODB++ format compatible applications must be able to represent the ODB++ product model correctly. For example, if two individual features do not touch, this relationship must be maintained by the ODB++ compatible application.

Minimum resolution for maintaining feature representation is 1/400 micron (1/10160 mil). Minimum line or arc width is 1/400 micron. Minimum measurable distance, or placement tolerance, for any feature is 1/400 micron.

Measurements such as coordinates and distances must be within the supported range. The Cartesian coordinates supported are within the range of (-100, -100) to (100, 100) inches, which is (-2450, -2450) to (2450, 2450) mm.

Files that contain measurable entities must include the UNITS directive, to specify whether measurements in the file are given in metric units (UNITS=MM) or in imperial units (UNITS=INCH). The UNITS directive is placed before the first line that uses units. Only one UNITS directive can appear in a file.

The default units of measurement for the product model are as defined in the UNITS directive in the file *misc/info* of the product model. If the default is not defined for the product model, the default is imperial.

For newly created files, units are based on the default defined for the product model.

For each file described in this document, there is a table of information. The UNITS row of the file information table indicates whether the UNITS directive is required for that file:

<file_name>	
Type	One of these strings: <ul style="list-style-type: none"> • Line Record Text • Structured Text
Compression	One of these strings: <ul style="list-style-type: none"> • None • Yes
Path	Path to the file.
UNITS	One of these strings: <ul style="list-style-type: none"> • The UNITS directive is required. • The UNITS directive is not relevant for the <file_name> file.

Files that Must Contain the UNITS Directive

File Name	Path
<i>info</i>	<product_model_name>/misc
<i>sysattr</i> <i>sysattr.dfm</i> <i>sysattr.fab</i> <i>sysattr.assy</i> <i>sysattr.test</i> <i>sysattr.gen</i> <i>userattr</i>	<product_model_name>/misc
<i>attrlist</i>	<product_model_name>/misc <product_model_name>/steps/<step_name> <product_model_name>/steps/<step_name>/layers/<layer_name> <product_model_name>/symbols/<symbol_name> <product_model_name>/wheels/<wheel_name>
<i>stephdr</i>	<product_model_name>/steps/<step_name>
<i>profile</i>	<product_model_name>/steps/<step_name> <product_model_name>/steps/<step_name>/layers/<layer_name>
<i>data</i>	<product_model_name>/steps/<step_name>/eda

File Name	Path
<i>features</i>	<product_model_name>/steps/<step_name>/layers/<layer_name> <product_model_name>/symbols/<symbol_name>
<i>tools</i>	<product_model_name>/steps/<step_name>/layers/<layer_name>
<i>components</i>	<product_model_name>/steps/<step_name>/layers/comp_+_top <product_model_name>/steps/<step_name>/layers/comp_+_bot
<i>netlist</i>	<product_model_name>/steps/<step_name>/netlists/cadnet <product_model_name>/steps/<step_name>/netlists/refnet

How Measurements Are Stored

According to the unit of measurement selected, data is stored in these units:

Type of Data	Metric (UNITS=MM)	Imperial (UNITS=INCH)
area	square mm	square inch
copper weight	μm In metric units, copper weight is actually copper thickness. The application converts it accordingly into commonly used neutral units (thickness or weight).	ounce per square foot
current	amps	amps
distances, sizes, coordinates	mm	inch
resistance	ohm	ohm
temperature	centigrade	fahrenheit
voltage	volts	volts
weight	gram	ounce

How the UNITS Directive Specifies Units of Measurement

Location of UNITS Directive	Scope	Example
There is no UNITS directive in <product_model>/misc/info.	The default units of measurement for the product model is imperial units.	None

Location of UNITS Directive	Scope	Example
There is a UNITS directive in <i><product_model>/misc/info</i> .	The units of measurement specified in this UNITS directive is the default for the product model.	<i>info</i> file example: <pre> JOB_NAME=odbv_demo_mm ODB_VERSION_MAJOR=8 ODB_VERSION_MINOR=1 ODB_SOURCE= CREATION_DATE=20170913.130051 SAVE_DATE=20170914.132825 SAVE_APP=Valor NPI 10.1 SAVE_USER=roni UNITS=MM MAX_UID=431990 </pre>
If there is a UNITS directive in a file that supports it, and there are no other specifications of units of measurement in the file.	The units of measurement specified in the UNITS directive is used for all measurements in the file.	<i>stephdr</i> file example: <pre> UNITS=INCH X_DATUM=0 Y_DATUM=0 X_ORIGIN=0 Y_ORIGIN=0 TOP_ACTIVE=0 BOTTOM_ACTIVE=0 RIGHT_ACTIVE=0 LEFT_ACTIVE=0 AFFECTING_BOM= AFFECTING_BOM_CHANGED=0 ID=0 </pre>
There is a UNITS directive in a file that supports it, and individual records in the file also specify units of measurement.	The units of measurement specified in the UNITS directive is used except where this is overridden by the specification in an individual record in the file.	<i>features</i> file example: <p>The "I" at the end of the symbol definition line specifies imperial units. This overrides the specification of UNITS=MM.</p> <pre> UNITS=MM ID=616 # #Num Features # F 12397 # #Feature symbol names \$0 oval210x170 I </pre>

ODB++ Attributes

Attributes in the ODB++ format provide a flexible way to assign product related and process related information to ODB++ entities. The use of attributes by the ODB++ format has been standardized and is supported in a unified manner, independent of any application-specific references to attributes. All system attributes are optional.

Attribute definition files for all attributes in the product model are stored under `<product_model_name>/misc`. They all have the same syntax.

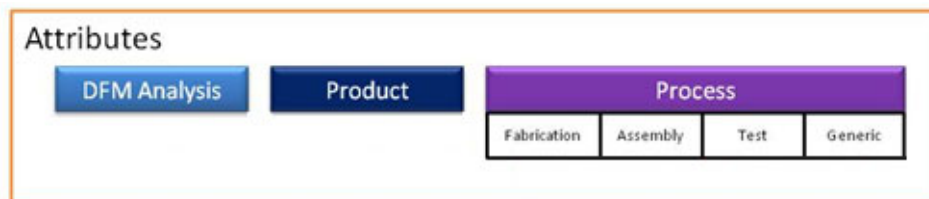
Attributes starting with the dot (.) character are system attributes. See “[misc/sysattr.* \(Attribute Definition\)](#)” on page 86.

User-defined attributes cannot have the dot character before their name. See “[misc/userattr \(User Attribute Definition\)](#)” on page 92.

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Attribute Classes

At the highest level, attributes within the ODB++ format are divided into these classes: DFM Analysis, Product, and Process.



- **DFM Analysis** attributes — Used to enable or enhance analysis. An example is `.center_fiducial` for components that require a center fiducial.
- **Product** attributes — Used to describe the finished product. An example is `.gold_plated` on a copper features to indicate that gold will be delivered at these locations.
- **Process** attributes — Used to add further definition to the manufacturing process applied to the product. Process attributes are divided into process categories:
 - **Fabrication** — For example, the fabrication process attribute `.plating_bar` describes the manufacturing purpose for a piece of copper that is later removed by the milling/routing process and is not delivered to the customer as part of the final product.
 - **Assembly** — For example, the assembly process attribute `.fs_direction_top` is used to describe the flow solder assembly direction.

- **Test** — These attributes are for the functional, optical, and other testing of the PCBA product before, during or following the assembly process. An example would be the HP3070 attributes used to deliver programs for this test machine.
- **Generic** — The generic attributes related to the production process.

The attribute definitions for each attribute class are stored in a separate file.

In addition to the files that contain system attribute definitions, the file *userattr* can be used to define user attributes for all entities. It is stored in the library when the product model is created. It is read each time the product model is opened.

These files contain attribute definitions:

Attribute Definition File	Class	List of System Attributes in the Class
<i>sysattr</i>	Product	“ Product (sysattr) ” on page 271
<i>sysattr.dfm</i>	DFM analysis	“ DFM (sysattr.dfm) ” on page 276
<i>sysattr.fab</i>	Fabrication	“ Fabrication (sysattr.fab) ” on page 279
<i>sysattr.assy</i>	Assembly	“ Assembly (sysattr.assy) ” on page 281
<i>sysattr.test</i>	Test	“ Test (sysattr.test) ” on page 283
<i>sysattr.gen</i>	Generic	“ Generic (sysattr.gen) ” on page 284
<i>userattr</i>	(none)	(Contains user-defined attributes.)

Attribute Value Assignment

You can assign system attributes and user-defined attributes to ODB++ entities. For some entities, attributes are assigned using an *attrlist* file. For some entities, attributes are assigned using a lookup table.

Attrlist Files

For some entities, an *attrlist* file is placed under the entity, containing a list of attribute names and values. For example, this *attrlist* file assigns attributes to the layer named *<layer_name>*:
<product_model_name>/steps/<step_name>/layers/<layer_name>/attrlist:

```
UNITS=MM
.out_mirror = no
.inp_file =
.eda_layers = "signal_2","signal","VIA"
.out_angle = 0.0
.out_polarity = positive
.out_x_scale = 1.000000
.out_y_scale = 1.000000
.out_comp = 0.000000
```

Lookup Tables

For entities for which multiple entities are defined in the same file—such as features, components, or nets—each entity definition line can contain attribute assignments for the entity being defined. Lookup tables are used to allow the entity assignment syntax to use shortcuts to refer to attributes and their values. This is an example of a feature attribute lookup table, and a feature definition record that assigns attributes by pointing to attributes and their values in the string 3=2,4=0:

```
#
#Feature attribute names
#
@0 .smd
@1 .nomenclature
@2 .test_point
@3 .geometry
@4 .pad_usage
#
#Feature attribute text strings
#
&0 9796334
&1 fid_0_0_0
&2 moire
#
#Layer features
#
P -0.198 1.62 16 P 0 3;3=2,4=0;ID=123456
```

ODB++ Entities That Can Have Attributes Assigned Using Lookup Tables

ODB++ Entity	File with Attribute Lookup Tables	Explanation
Symbol Feature	<i>/symbols/<symbol_name>/features</i>	“<symbol_name>/features (Symbol Features)” on page 95
Net	<i>/steps/<step_name>/eda/data</i>	“eda/data (EDA Data)” on page 109
Feature	<i>/steps/<step_name>/layers/ <layer_name>/features</i>	“<layer_name>/features (Graphic Features)” on page 170
Component	<i>/steps/<step_name>/layers/ <layer_name>/components</i>	“<layer_name>/components (Components)” on page 153

ODB++ Entities That Can Have Attributes Assigned in an attrlist File

ODB++ Entity	attrlist File	Explanation
Product Model	<i><product_model_name>/misc/ attrlist</i>	“misc/attrlist (Product Model Attribute List)” on page 76

ODB++ Entity	attrlist File	Explanation
Symbol	<i>/symbols/<symbol_name>/attrlist</i>	“<symbol_name>/attrlist (Symbol Attribute List)” on page 94
Wheel	<i>/wheels/<wheel_name>/attrlist</i>	“<wheel_name>/attrlist (Wheel Attribute List)” on page 96
Step	<i>/steps/<step_name>/attrlist</i>	“<step_name>/attrlist (Step Attribute List)” on page 100
Layer	<i>/steps/<step_name>/layers/<layer_name>/attrlist</i>	“<layer_name>/attrlist (Layer Attribute List)” on page 152

Unique ID

The ODB++ format supports the permanent reference of entities through the use of indices for unique IDs. The unique ID is optional, but once assigned, is never changed, and no other entity within the product model can bear the same ID.

IDs are represented by a positive number between 0 and 4294967295.

Unique IDs are generated for use in the product model definition of these files: *matrix*, *stephdr*, *features*, *components*, and *profile*. The largest unique ID used in the product model is stored in the *info* file. See “[misc/info \(Basic Product Model Information\)](#)” on page 77.

The *stephdr*, *features*, *components*, and *profile* files can also have their own individual ID record to uniquely identify the file itself.

A feature file with an ID of 216 would look like this:

```
UNITS=INCH
ID=216
...
#
#Feature symbol names
#
$0 r4
$1 r5
```

A component file with an ID of 843 would look like this:

```
UNITS=INCH
ID=843
#
#Component attribute names
#
@0 .comp_height
@1 .package_type
"
```

Format Definition

All files in the ODB++ format are ASCII files.

In all files, the hash (#) character specifies a comment. Lines that start with this character should be ignored, and are only used for readability.

The line separator can be either <LF> or <CR><LF>, depending on operating system and platform.

Extensible Content

Third parties are free to place additional content in the ODB++ file structure. Third parties are not constrained to using ASCII format, and are free to use encrypted or non-encrypted formats such as binary, ASCII, XML, and others. But that content is outside the format specification described for ODB++.

Large File Compression

One of the reasons vendors have chosen binary data in the past was the need to conserve disk space. Modern compression techniques provide excellent compression ratios, especially for ASCII files with repetitive patterns. Large files in ODB++ format are saved in standard UNIX compression format. The compression is optional. Software reading the ODB++ product model structure should expect some files to be compressed (.Z) and some not.

For each file described in this document, there is a table of information. Files that are potentially compressed are identified, in this document, in the Compression row of the file information table in the description of the file:

<file_name>	
Type	One of these strings: <ul style="list-style-type: none"> • Line Record Text • Structured Text
Compression	One of these strings: <ul style="list-style-type: none"> • None • Yes
Path	Path to the file.
UNITS	One of these strings: <ul style="list-style-type: none"> • The UNITS directive is required. • The UNITS directive is not relevant for the <file_name> file.

Structured Text Files

Many text files in ODB++ format contain structured text. The main advantages of this file type is readability. The user can open a file and understand its contents without needing to refer to external sources.

Structured text files contain expressions in this format:

```
<variable>=<value>
```

A more elaborate structure, which appears in some structured text files, describes arrays. Arrays are lists of elements, each one containing several fields. The expression `<variable>=<value>` appears multiple times, each time defining an element of the array:

```
<array_name> {  
  <variable>=<value>  
  <variable>=<value>  
  ....  
}
```

For each file described in this document, there is a table of information. Structured text files are identified as such in the Type row of the file information table:

<file_name>	
Type	One of these strings: <ul style="list-style-type: none">• Line Record Text• Structured Text
Compression	One of these strings: <ul style="list-style-type: none">• None• Yes
Path	Path to the file.
UNITS	One of these strings: <ul style="list-style-type: none">• The UNITS directive is required.• The UNITS directive is not relevant for the <i><file_name></i> file.

Example of a <variable>=<value> Expression

```
X_DATUM=0.3
```


Example of an Array

```
LAYER {
  ROW=1
  CONTEXT=BOARD
  TYPE=COMPONENT
  NAME=COMP_+_TOP
  POLARITY=POSITIVE
  START_NAME=
  END_NAME=
  OLD_NAME=
  ADD_TYPE=MICRO_VIA
  COLOR=606090
}
```

Line Record Text Files

In some ODB++ files, each line contains multiple fields, typically separated by space characters. Typically, the first character or string in each line defines the type of record that the line describes. In many cases, the line order is significant.

The ODB++ format permits line length of up to 1,400 characters. A line longer than this can be truncated.

For each file described in this document, there is a table of information. Line record text files are identified as such in the Type row of the file information table:

<file_name>	
Type	One of these strings: <ul style="list-style-type: none"> • Line Record Text • Structured Text
Compression	One of these strings: <ul style="list-style-type: none"> • None • Yes
Path	Path to the file.
UNITS	One of these strings: <ul style="list-style-type: none"> • The UNITS directive is required. • The UNITS directive is not relevant for the <file_name> file.

Example of a Line Record Text File

```
#
#Feature symbol names
#
$0 r50
$1 r70
$2 r80
$3 r93
$4 ths80x60x0x4x15
#
#Feature attribute names
#
@0 .geometry
@1 .pad_usage
#
#Feature attribute text strings
#
&0 systest_board
&1 term_1
&2 via_1
#
#Layer features
#
L -0.4 -3.6 -0.4 -4 0 P 0;0=0
L -0.4 -4 0 -4 0 P 0;0=0
L -0.4 -1.4 -0.4 -1 0 P 0;0=0
L -0.4 -1 0 -1 0 P 0;0=0
```

Coordinates

From ODB++ format v8.0, the UNITS directive must be present in every file that contains coordinates or measurements.

In ODB++ format v7.x, the units directive described the units applied in the feature file; and when not present, imperial units were assumed. Therefore, coordinates were expressed in inches; symbol sizes were expressed in mils.

When specifying a fractional coordinate, the separator for decimal numbers must be a period (.) For example, s3.25 2.456. No other representation of numbers is allowed (such as scientific notation, exponential, or others).

Angles

All angles are defined by a positive value between 0 and 360 degrees.

Rotation and Mirroring

These are the rules for rotation and mirroring.

- Feature pads can be rotated. Rotation is expressed in degrees or in multiples of 90 degrees, and is always clockwise.
- Mirroring occurs only along the x-axis (left to right, changing x coordinates).
- If both rotation and mirroring are performed, the feature is first rotated, and then mirrored.

Symbols

Symbols define a wide variety of shapes that are mostly used to represent pads.

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Standard Symbols

Standard symbols are rendered dynamically from their names. They do not require that a graphic symbol entity be saved. They are round, square, or parametric shapes.

The names of standard symbols have this structure:

`<symbol_name_prefix>[<parameter_value>[x<parameter_value>[...]]]`

where parameter_value is a decimal number, integer or real. Parameter values are delimited with an x character.

For example, a rounded square thermal is specified using a name like this:

`s_ths200x180x15x5x10xr20`

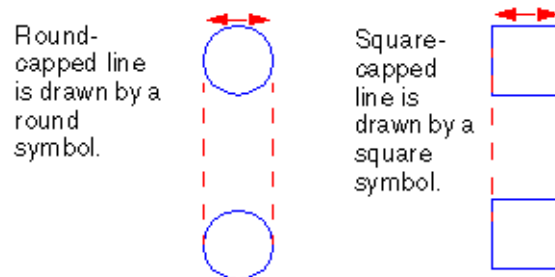
- `s_ths` — Symbol name prefix.
- `200, 180, 15, 5, 10, r20` — Parameter values presented in the required order.

Note



When specifying a fractional symbol size, the separator for decimal numbers must be a period (.). For example, `s3.25`.

Symmetric symbols (round symbols, or square symbols where width = height) are required to create lines and arcs. The width of a line or arc is the width of the symmetric symbol used to draw it. See “[Lines and Arcs Drawn with Symbols](#)” on page 38.



Units for parameters that represent size are expressed as a thousandth part of an inch or as a micron, depending on the current UNITS directive. See “[Units of Measurement](#)” on page 23 for a discussion of the UNITS directive.

ODB++ format guarantees precision for standard symbol dimensions in non-integers with resolutions of up to 1/100 mils.

Symbol r0 is a legal entity. Its area is 0, and it is recommended to display it with a single display pixel.

Standard symbols are all positive filled shapes. Holes in symbols are see-through by definition. The internal implementation of complex symbols uses arc or contour data with cutouts.

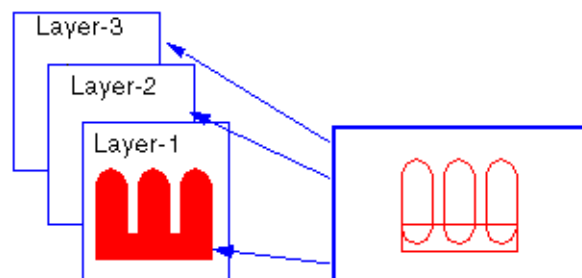
User-Defined Symbols

User-defined symbols have a full graphic description stored in *features* files in the product model *symbols* directory. A user-defined symbol can contain any number of features, including any number of other user-defined symbols. Circular references are prohibited. User-defined symbols are typically created for shapes that are not found among the standard symbols.

A user-defined symbol is an ODB++ entity that is defined once and can be used multiple times, to avoid repeating the definition of a group of features on a layer. A symbol definition contains a *features* file that specifies the primitive features (such as pad, line, arc, surface, and text) that comprise the symbol on the layer. See “[<symbol_name>/features \(Symbol Features\)](#)” on page 95.

It is preferable to use a standard symbol, where possible. User-defined symbols require more memory than standard symbols, and having a large number of them will slow down processing.

A symbol can be referenced from multiple layers in the product model, at different coordinates. Changing the symbol definition will automatically cause all its representations in the layers to change accordingly.



Standard symbol name prefixes are reserved for use in standard symbol names and cannot be assigned to user-defined symbols. Standard symbol name prefixes cannot be used for user-defined symbols even if the name of the user-defined symbol has a different format from that of the standard symbol, or if the user-defined symbol allows parameter values that are illegal in the

standard symbol with that prefix. For a list of these reserved names, see “[Basic Standard Symbols](#)” on page 195.

Like standard symbols, user-defined symbols are scalable.

See “[<layer_name>/features \(Graphic Features\)](#)” on page 170 for an example of the UNITS directive in the *features* file.

This user-defined symbol represents an arrow whose origin (0,0) is at the head of the arrow on the left. It is drawn from lines (standard symbols). When inserting this symbol, the insertion point is at (0, 0).

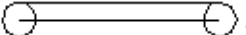


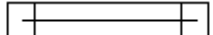
Lines and Arcs Drawn with Symbols

Lines and arcs are created by a symbol and two points—a start point and an end point. Lines and arcs are drawn by dragging the symbol by its center along a line or circular curve from one end to the other.

For arcs, only round symbols can be used.

If the symbol used to draw a line is symmetrical (square or round) the width of the generated line is the side or the diameter of the symbol.

A round symbol (whose name starts with r) generates round line ends .

A square symbol (whose name starts with s) generates square line ends .

Using non-symmetric symbols (standard or user-defined) for the drawing of lines is not recommended, because their implementation tends to be inefficient. If such lines are found in a product model, the application must decide how to handle them. The result should resemble the sweep of the symbol from its start point to its end point.

Surfaces

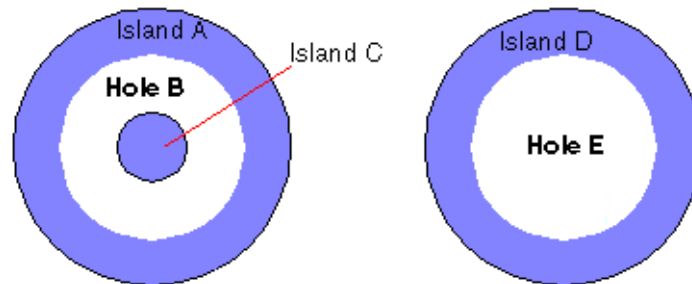
A surface is a feature that represents a legal contour.

A surface has these properties:

- The islands of a contour do not overlap.
- Holes inside islands do not intersect.
- Islands and holes are ordered in a specific way.

The order of containment of holes and islands within surfaces determines their natural order. The outermost island comes first. Islands precede holes that are contained in them. Holes precede islands that are contained in them.

In this example, the natural containment order would be A, B, C, D, E. Island D is separate from island A.



Polygons must meet these restrictions:

- Self-intersecting polygons (SIPs) are not allowed.
- Polygons, both the island and holes, must be sequenced to form a closed shape. That means that all polygons must contain at least three segments, and the last record point must be the same as the first.
- Edge lengths should be greater than zero.
- Holes must be graphically contained inside island polygons.
- The direction of segments representing the edges of an island must be clockwise, and the direction of segments representing the edges of holes must be counter-clockwise.
- The curves must be consistent—the start, end, and center point must construct a legal curve.

Geometric Entities

The ODB++ format uses geometric primitives called features to describe product model geometry. Features are stored in the feature containers of layers, profiles, and symbols. The types of geometric entities supported by the ODB++ format are the pad, line, arc, surface, and text.

These primitives are defined by the concept of a symbol and a contour.

- **Symbol** — A symbol is either one of the geometric primitives supported by the ODB++ format described in “[Basic Standard Symbols](#)” on page 195, or a combination of them.
- **Contour** — A contour is represented by single or multiple islands. An island is the area inside a boundary that consists of straight and circular segments. Islands in a contour do not touch or intersect with one another. Each island can contain holes that are also defined by a boundary. Those boundaries are referred to as polygons. The boundary of an island is oriented clockwise; the boundary of a hole is oriented counter-clockwise.

Features can be positive or negative. Positive features cover all underlying parts of features previously added to the feature container. Negative features erase all underlying parts of features previously added to the feature container.

These geometric entities are supported by the ODB++ format:

- **Arc** — Created by dragging a symbol along a circular segment. Arcs are defined by their start point, end point, center, direction (clockwise or counter-clockwise), and symbol.

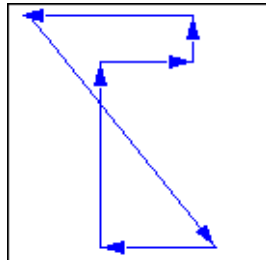
When the start-point and end-point of an arc coincide, it is considered a 360 degree arc. There are no single-point arcs in the ODB++ format.

- **Surface** — A solid polygon that can contain non-intersecting islands, that themselves can contain any number of holes.
- **Text** — Consists of letters drawn with a font or barcode. Text is defined by a text string, font, and text size. See “[fonts/standard \(Standard Font\)](#)” on page 48 and “[B — Barcode Records](#)” on page 183.
- **Pad** — The most primitive geometric entity. A pad is a point made with a symbol. Pads are defined by their location and their symbol.
- **Line** — Created by dragging a symbol along a straight segment. Lines are defined by their start point, end point, and symbol.

Self-Intersecting Polygons (SIP)

In all polygon representations, a self-intersecting polygon (SIP) is illegal. A SIP is a polygon with a boundary that intersects itself at one or more points.

Polygons can represent, for example, graphic surfaces or component package bodies.



Legal polygons are those whose edges intersect only at endpoints of consecutive edges.

SIPs impede the correct representation of required product model elements and hinder their mathematical representation. These are some examples of problematic operations:

- Correct rendering of layer graphics.
- Resizing (enlarging, shrinking, changing shape).
- Calculation of copper areas, where unambiguous definition of the copper location is essential.

Component Variants

The definition of component variants within ODB++ is based on the active BOM applied to a step of the product model. The existence of multiple variants indicates which components should be used, based on the currently applied BOM.

The active BOM is specified in the AFFECTING_BOM field of the *stephdr* file.

The ODB++ format displays a variant by applying the attribute Not Populated per BOM (.no_pop) for components that are not to be used.

See “<step_name>/boms (Bill of Materials)” on page 101.

These attributes control the use of component variants:

Attribute Name	Internal name	Explanation
Product Model Variant List	.variant_list	This product model attribute contains a list of all variants available within the product model, using a colon (:) as a separator. For example, this value would represent three variants, build_1, build_2 and build_3: .variant_list=build_1:build_2:build_3
Active Variant	.current_variant	This step attribute can contain one of the variant names listed in attribute Product Model Variant List, if one has been selected. If no variant is currently applied, then its value is empty.

Attribute Name	Internal name	Explanation
Variant List	.comp_variant_list	<p>When attribute Active Variant is applied, this component attribute should already be applied to each component. This attribute contains the list of variants of which the component is a member. The list contains the names of all relevant variants, separated by colons (:).</p> <p>When the attribute Active Variant contains a variant name, components that are not members of that variant should bear the attribute Not Populated per BOM (.no_pop).</p>

Chapter 2

Product Model Tree

An ODB++ product model is a directory containing sub-directories that represent ODB++ entities. These charts illustrate the directory hierarchy.

Users can create additional files in the *user* directory related to each entity as long as they do not conflict with ODB++ standard directories. Directories that are no longer supported might appear in ODB++ models containing legacy data.

<product_model_name>	43
<product_model_name>/steps	44
<product_model_name>/steps/<step_name>/layers	46

<product_model_name>

This is the top level product model directory tree.



These sub directories of the <product_model_name> directory are described:

Sub Directory	File	Link to Explanation
<i>steps</i>		“<product_model_name>/steps” on page 44.
<i>symbols</i>	<i>attrlist</i> <i>features</i>	“<symbol_name>/attrlist (Symbol Attribute List)” on page 94 “<symbol_name>/features (Symbol Features)” on page 95
<i>matrix</i>	<i>matrix</i>	“matrix/matrix (Matrix)” on page 62
<i>misc</i>	<i>attrlist</i> <i>last_save</i> <i>info</i> <i>metadata.xml</i> <i>sysattr files</i> <i>userattr</i>	“misc/attrlist (Product Model Attribute List)” on page 76 “misc/last_save (Last Time Product Model Saved)” on page 77 “misc/info (Basic Product Model Information)” on page 77 “misc/metadata.xml (Metadata)” on page 79 “misc/sysattr.* (Attribute Definition)” on page 86 “misc/userattr (User Attribute Definition)” on page 92
<i>wheels</i>	<i>attrlist</i> <i>dcodes</i>	“<wheel_name>/attrlist (Wheel Attribute List)” on page 96 “<wheel_name>/dcodes (Dcodes)” on page 96
<i>fonts</i>	<i>standard</i>	“fonts/standard (Standard Font)” on page 48

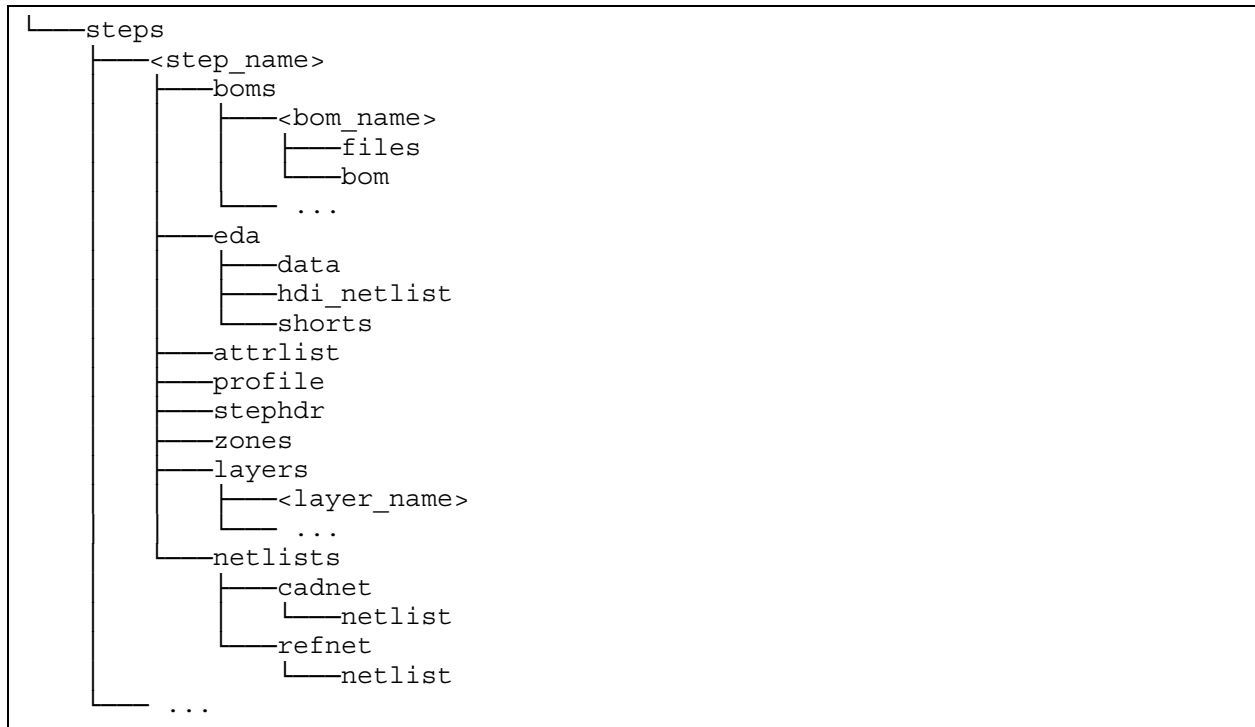
<product_model_name>/steps

A product model contains one or more step entities.

Each step entity can containsome or all of these entities.

- Layers included in the step.
- Step and repeat information — The *stephdr* file specifies any steps that are included in this one and their relative location and orientation.
- Netlist description of the step — CAD netlist and reference netlist.
- An EDA object — This contains information about the component packages and pins. It also contains information about the relation of features in the board layers to specific design nets and properties imported from the EDA system. It can contain a definitions of intentional shorts.
- A profile — A border around the step representing the board edge.
- Zone definitions — A cross sectional view of areas of the step profile.

This chart represents the directory tree under each step:

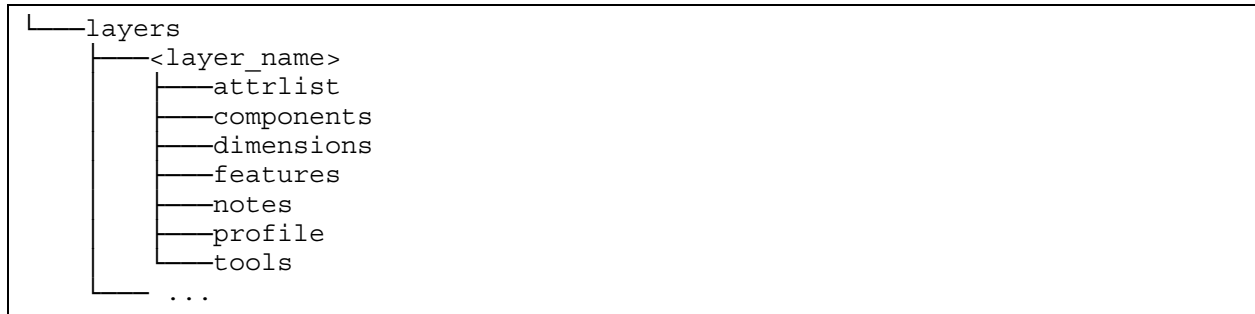


These files and sub directories of the <step_name> directory are described:

Sub Directory	File	Link to Explanation
	<i>stephdr</i>	“<step_name>/stephdr (Step Header)” on page 143
	<i>attrlist</i>	“<step_name>/attrlist (Step Attribute List)” on page 100
<i>layers</i>		See “Layer Entities” on page 151.
<i>netlists</i>	<i>cadnet</i>	“cadnet/netlist (cadnet)” on page 135
	<i>refnet</i>	“refnet/netlist (Reference)” on page 141
	<i>profile</i>	“<step_name>/profile (Outline Shape of Step)” on page 141
<i>boms</i>	<i>bom</i>	“<bom_name>/bom (Bill Of Materials)” on page 101
	<i>files</i>	“<bom_name>/files (Source Files)” on page 106
<i>eda</i>	<i>data</i>	“eda/data (EDA Data)” on page 109
	<i>shorts</i>	“eda/shorts (Electrical Intention Short Net)” on page 120
<i>zones</i>		“<step_name>/zones (Matrix Broken Into Sections)” on page 145

<product_model_name>/steps/<step_name>/layers

This chart represents the directory tree under each layer.



These files of the <layer_name> directory are described:

File	Link to Explanation
<i>attrlist</i>	“<layer_name>/attrlist (Layer Attribute List)” on page 152
<i>profile</i>	“<layer_name>/profile (Outline Shape of Layer)” on page 188
<i>features</i>	“<layer_name>/features (Graphic Features)” on page 170
<i>components</i>	“<layer_name>/components (Components)” on page 153
<i>tools</i>	“<layer_name>/tools (Drill Tools)” on page 191
<i>notes</i>	“<layer_name>/notes (Electronic Notes)” on page 188

Chapter 3

Product Model Entities

Several ODB++ entities are defined at the product model level.

For a list of mandatory files and directories, see “[File System](#)” on page 22.

ext (Extension)	47
fonts (Fonts Used in Product Model)	48
fonts/standard (Standard Font)	48
input (Input)	50
matrix (Product Model Matrix)	51
matrix/stackup.xml (Stackup)	52
matrix/matrix (Matrix)	62
misc (Miscellaneous)	76
misc/attrlist (Product Model Attribute List)	76
misc/last_save (Last Time Product Model Saved)	77
misc/info (Basic Product Model Information)	77
misc/metadata.xml (Metadata)	79
misc/sysattr.* (Attribute Definition)	86
misc/userattr (User Attribute Definition)	92
steps	93
symbols (User-Defined Symbols)	94
<symbol_name>/attrlist (Symbol Attribute List)	94
<symbol_name>/features (Symbol Features)	95
user (User)	95
wheels (Gerber and Tool Wheels)	96
<wheel_name>/attrlist (Wheel Attribute List)	96
<wheel_name>/dcodes (Dcodes)	96

ext (Extension)

This directory is the location to store third party data files.

See “[Extensible Content](#)” on page 31.



fonts (Fonts Used in Product Model)

The one file relating to fonts is *standard*.

fonts/standard (Standard Font) 48

fonts/standard (Standard Font)

This file defines the vector representation of all the characters that can be a part of a text feature in a layer.

standard (Standard Font)	
Type	Line Record Text
Compression	None
Path	<product_model_name>/fonts/standard
UNITS	The UNITS directive is not relevant for the <i>standard</i> file.

Size is scaled according to text requirements.

The system supports fully the font named standard. See “[Standard Font](#)” on page 285.



The origin of each character is at the lower left corner. For best results, the font definition should include all ASCII characters.

The file consists of a header containing global parameters, followed by a character block to define each character.

Header Section

The header section consists of these lines:

Header Line	Explanation
XSIZE <size>	Horizontal size of a character.
YSIZE <size>	Vertical size of a character.
OFFSET <size>	Horizontal distance between the end of one character block and the beginning of the next one.

Character Block

A character block consists of these lines:

Character Block Line	Explanation
CHAR <char>	Defines the ASCII character defined by this block.
LINE <xs> <ys> <xe> <ye> <pol> <shape> <width>	<p>A character specification contains one or more LINE records, each defining a line used to construct the character.</p> <ul style="list-style-type: none"> • (xs, ys) — Starting point of the line. • (xe, ye) — Ending point of the line. • pol — Polarity of the line (P for positive, N for negative). • shape — The shape of the ends of the line (R for rounded, S for square). • width — Line width in mm or inches. <p>All coordinates are in mm or inches. Because fonts are scaled to a specific text style, units in the font definition are irrelevant. Coordinates and width can be expressed in any units.</p>
ECHAR	Ends the definition of a character.

Standard Font Characters

!	"	#	\$	%	&	'	()	*	+	,
-	.	/	0	1	2	3	4	5	6	7	8
9	:	;	<	=	>	?	@	A	B	C	D
E	F	G	H	I	J	K	L	M	N	O	P
Q	R	S	T	U	V	W	X	Y	Z	[\
]	^	_	`	a	b	c	d	e	f	g	h
i	j	k	l	m	n	o	p	q	r	s	t
u	v	w	x	y	z	{		}	~		

Example of a font file

The file consists of a header containing global parameters, followed by a character block to define each character.

```
XSIZE 0.302000
Ysize 0.302000
OFFSET 0.000000

CHAR!
LINE 0.000000 0.000000 0.000000 0.200000 P R 0.012000
LINE 0.000000 -0.100000 0.000000 -0.100000 P R 0.012000
ECHAR

...

CHAR ~
LINE -0.100000 0.150000 -0.050000 0.200000 P R 0.012000
LINE -0.050000 0.200000 0.050000 0.100000 P R 0.012000
LINE 0.050000 0.100000 0.100000 0.150000 P R 0.012000
ECHAR
```

input (Input)

This directory is the default location of files for input packages (not ODB++ files) in the product model.

```
└─<product_model_name>
   └─...
   └─input
└─...
```

matrix (Product Model Matrix)

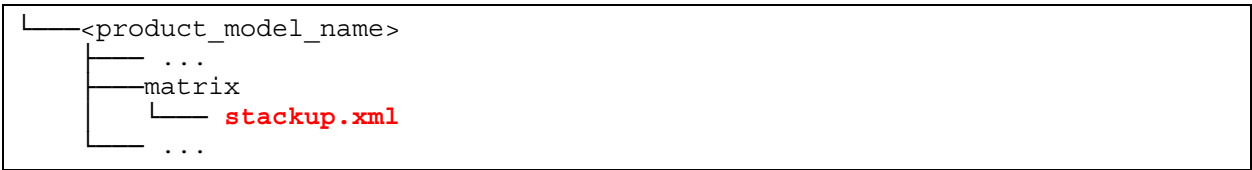
The *matrix* directory of the product model contains the matrix file or the stackup file. If both files exist, the matrix file takes precedence.

matrix/stackup.xml (Stackup)	52
matrix/matrix (Matrix)	62

matrix/stackup.xml (Stackup)

The stackup file contains all the material information required for the complete manufacturing process of a circuit board. It contains what was previously held in the matrix file with the addition of the material data.

StackupFile (Stackup)	
Type	XML
Compression	None
Path	<product_model_name>/matrix/stackup.xml



The stackup file will replace the matrix file in the next major release of the ODB++ format. In the meantime, the matrix file is required and the stackup file is optional. The format will rely on the matrix file as the primary source of data. If there is an inconsistency, the matrix file will be the primary source of matrix-related ODB++ content.

Structure of the Stackup File 53

Structure of the Stackup File

The stackup file contains one optional EdaData section and any number of optional SupplierData sections.

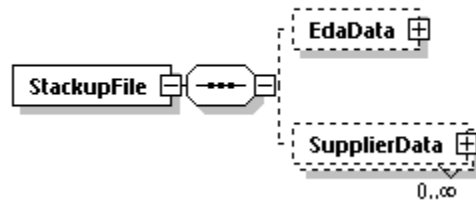
The EdaData and SupplierData sections have similar structure—both describe the characteristics of the printed board and its fabrication stackup, with the difference that the EdaData section contains design information retrieved from the CAD data, and the SupplierData section contains information related to the manufacturing and fabrication stackup process.

EdaData and SupplierData Sections	54
Specs > Spec Section	56
Stackup Section	60

EdaData and SupplierData Sections

The stackup file contains one optional EdaData section and any number of optional SupplierData sections.

Figure 3-1. Stackup File - EdaData and SupplierData Sections



EdaData

The EdaData section contains all the stackup-required content as delivered by the design source. This may be a generic section containing basic material requirements and impedance definition, or a full set of stackup definitions provided by a stackup software solution. This section is the basis for all stackup definitions and must not be altered in any way by stackup suppliers.

Child elements:

- **Specs** — A list of material specifications and impedance requirements for the stack design (1)
- **Stackup** — Stackup representation by the design source (1)

Example:

```
<EdaData CompanyName="Valor">
  <Specs>
    ...
  <Stackup StackupName="Step_1" StackupThickness="85">
    ...
</EdaData>
```

The schema is described in “[StackupFile/EdaData](#)” on page 332.

SupplierData

The SupplierData section represents instances of the manufacturing stackup, each with the required content determined by the supplier. This section should contain a full stackup defining the final materials and impedance calculation based on the material of use.

Child elements:

- **Specs** — A list of material specifications and impedance requirements for the stack design (1)
- **Stackup** — Stackup representation by a supplier (1)

Example:

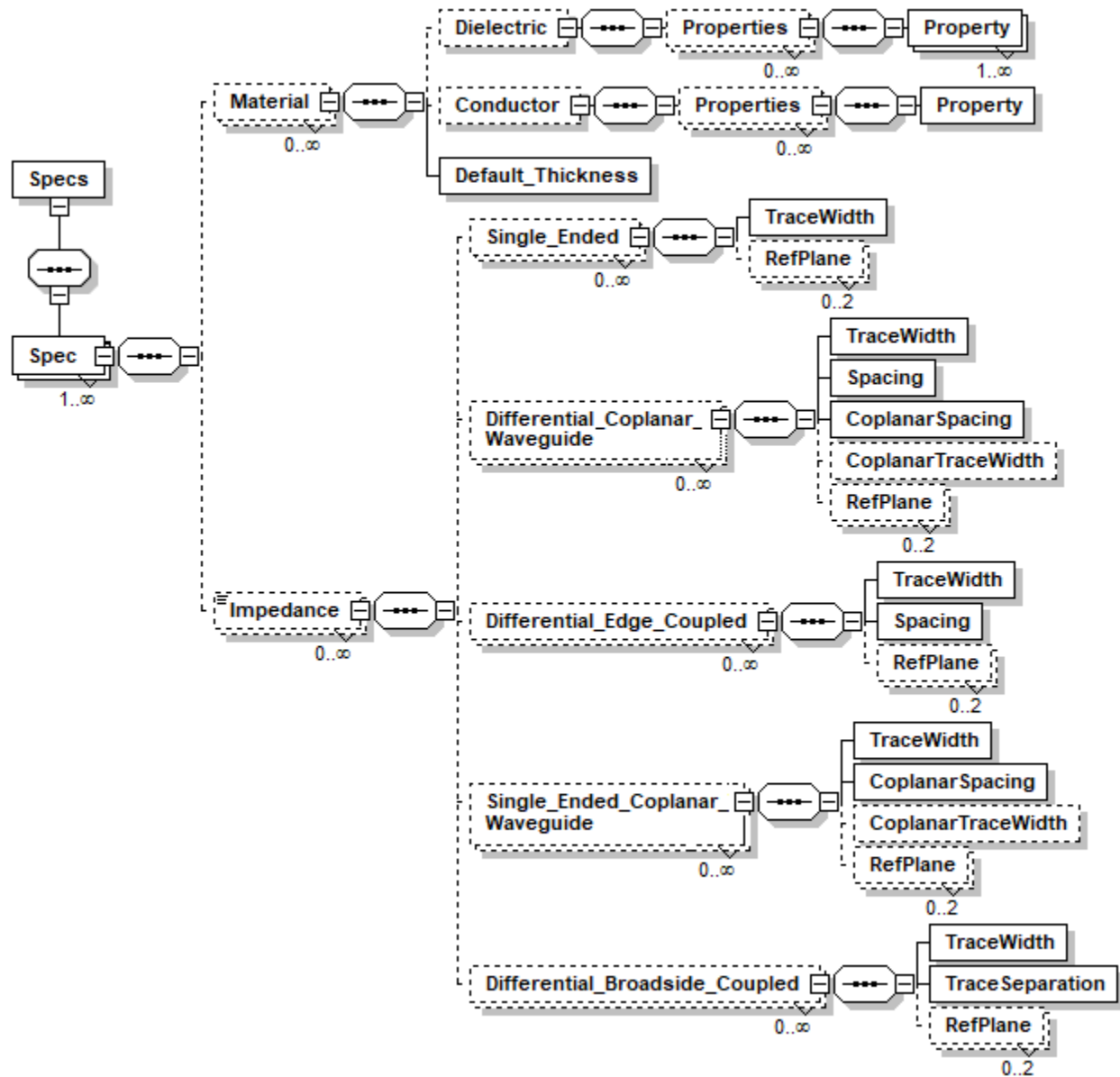
```
<SupplierData CompanyName="BetaBuildOne">  
  <Specs>  
    ...  
  <Stackup StackupName="Step_1" StackupThickness="85.2">  
    ...  
  </Stackup>  
</SupplierData>
```

The schema is described in “[StackupFile/SupplierData](#)” on page 395.

Specs > Spec Section

The Specs subsection of both EdaData and SupplierData sections includes at least one instance of the Spec element.

Figure 3-2. Stackup File - Spec Section



Specs

Contains a list of material specifications for the stack design and impedance requirements.

Child elements:

- **Spec** — Collection of materials and impedance requirements (0-n)

Example:

```
<Specs>
  <Spec SpecName="Valor">
    ...
  </Spec>
</Specs>
```

The schema is described in the following topics:

- “[StackupFile/EdaData/Specs](#)” on page 334.
- “[StackupFile/SupplierData/Specs](#)” on page 397

Spec

An individual specification defining the collection of materials and impedance requirements. The Spec is selected through the use of the SpecName attribute.

Child elements:

- **Material** — Material specification (0-n)
- **Impedance** — Impedance specification (0-n)

Example:

```
<Spec SpecName="Valor">
  <Material MaterialName="Soldermask">
    ...
  </Material>
  <Material MaterialName="0.5 oz CU">
    ...
  <Material MaterialName="Dielectric_1">
    ...
  </Material>
  <Impedance ImpName="SE 34 ohms" ZoValOhms="34">
    ...
  </Impedance>
  <Impedance ImpName="SE 38 ohms" ZoValOhms="38">
    ...
  </Impedance>
</Spec>
```

The schema is described in the following topics:

- “[StackupFile/EdaData/Specs/Spec](#)” on page 335.
- “[StackupFile/SupplierData/Specs/Spec](#)” on page 398

Material

A Material specification defining a specific material, dielectric or conductor. The Material is selected through the use of the MaterialName attribute.

Child elements:

- **Dielectric** — The definition of a specific piece of dielectric material (0-1)
- **Conductor** — The definition of a specific piece of conductive material (0-1)
- **Default_Thickness** — The thickness definition for the supplier-delivered dielectric or conductor material (1)

Example:

```
<Material MaterialName="Soldermask">
  <Dielectric DielectricType="OTHER" OtherSubType="SOLDER_MASK"/>
  <Default_Thickness Thickness="0.5"/>
</Material>
<Material MaterialName="0.5 oz CU">
  <Conductor ConductorType="COPPER" CopperWeight_oz_ft2="0.5"/>
  <Default_Thickness Thickness="0.7"/>
</Material>
<Material MaterialName="1.0 oz CU">
  <Conductor ConductorType="COPPER" CopperWeight_oz_ft2="1.0"/>
  <Default_Thickness Thickness="1.4"/>
</Material>
<Material MaterialName="Dielectric_1">
  <Dielectric DielectricType="UNDEFINED"/>
  <Default_Thickness Thickness="3.6"/>
</Material>
```

The schema is described in the following topics:

- [“StackupFile/EdaData/Specs/Spec/Material”](#) on page 336.
- [“StackupFile/SupplierData/Specs/Spec/Material”](#) on page 399

Impedance

An Impedance specification defining the general impedance goal and physical characteristics. The Impedance is selected through the use of the ImplName attribute.

Child elements:

- **Single_Ended** — A representation of the single-ended impedance requirement (0-n)
- **Differential_Coplanar_Waveguide** — A representation of the differential Coplanar waveguide impedance requirement (0-n)
- **Differential_Edge_Coupled** — A representation of the edge-coupled differential impedance requirement (0-n)

- **Single_Ended_Coplanar_Waveguide** — A representation of the Coplanar single-ended waveguide impedance requirement (0-n)
- **Differential_Broadside_Coupled** — A representation of the broadside-coupled differential impedance requirement (0-n)

Example:

```
<Impedance ImpName="DIFF100 ohms">
  <Differential_Edge_Coupled LayerName="t04" ZoCalculatedOhms="50.8"
ZDiffCalculatedOhms="101.5">
    <TraceWidth TraceWidthBottom="4.1"/>
    <Spacing Val="8"/>
    <RefPlane RefLayerName="g03"/>
  </Differential_Edge_Coupled>
  <Differential_Edge_Coupled LayerName="t05" ZoCalculatedOhms="50.8"
ZDiffCalculatedOhms="101.5">
    <TraceWidth TraceWidthBottom="4.1"/>
    <Spacing Val="8"/>
    <RefPlane RefLayerName="p06"/>
  </Differential_Edge_Coupled>
  <Differential_Edge_Coupled LayerName="t07" ZoCalculatedOhms="50.3"
ZDiffCalculatedOhms="100.5">
    <TraceWidth TraceWidthBottom="4.2"/>
    <Spacing Val="8"/>
    <RefPlane RefLayerName="p06"/>
  </Differential_Edge_Coupled>
</Impedance>
```

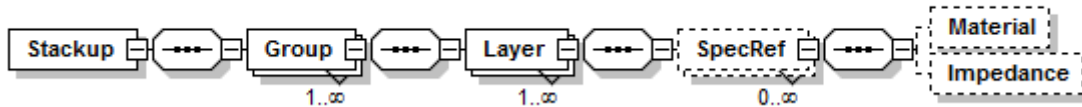
The schema is described in the following topics:

- “[StackupFile/EdaData/Specs/Spec/Impedance](#)” on page 348.
- “[StackupFile/SupplierData/Specs/Spec/Impedance](#)” on page 411

Stackup Section

Both the EdaData and SupplierData sections include one mandatory instance of the Stackup element.

Figure 3-3. Stackup File - Stackup Section



Stackup

The stackup representation.

Child elements:

- **Group** — Collection of Materials in which conductor materials are tied to copper layers of the design (1-n)

Example:

```
<Stackup StackupName="Step_1" StackupThickness="85">  
  <Group GroupName="Design">  
    ...  
  </Group>  
</Stackup>
```

The schema is described in the following topics:

- “[StackupFile/EdaData/Stackup](#)” on page 385.
- “[StackupFile/SupplierData/Stackup](#)” on page 447

Group

A stackup is created from Groups. A Group is a collection of Materials in which conductor materials are tied to copper layers of the design. Each series is represented from the top of the stack to the bottom.

Child elements:

- **Layer** — Layer definition within the Group (1-n)

Example:

```
<Group GroupName="Design">
  <Layer LayerName="top" LayerType="SIGNAL" Side="TOP">
    ...
  </Layer>
  <Layer LayerName="dielectric_1" LayerType="DIELECTRIC" Side="INNER">
    ...
  </Layer>
</Group>
```

The schema is described in the following topics:

- [“StackupFile/EdaData/Stackup/Group”](#) on page 387.
- [“StackupFile/SupplierData/Stackup/Group”](#) on page 449

Layer

A layer definition within the Group.

Child elements:

- **SpecRef** — The list of Material and Impedance Specs, and conductor requirements for a layer (0-n)

Example:

```
<Layer LayerName="top" LayerType="SIGNAL" Side="TOP">
  <SpecRef MaterialSpecName="Valor">
    <Material MaterialName="0.5 oz CU" FrequencyVal="5"
    CopperAreaPrecent="25"/>
  </SpecRef>
</Layer>
```

The schema is described in the following topics:

- [“StackupFile/EdaData/Stackup/Group/Layer”](#) on page 389.
- [“StackupFile/SupplierData/Stackup/Group/Layer”](#) on page 451

matrix/matrix (Matrix)

The matrix is a representation of the product model in which the rows are the product model layers—sheets on which elements are drawn for plotting, drilling and routing or assembly; and the columns are the product model steps—multi-layer entities such as single images, assembly panels, production panels and coupons.

matrix (Matrix)	
Type	Structured Text
Compression	None
Path	<product_model_name>/matrix/matrix
UNITS	The UNITS directive is not relevant for the <i>matrix</i> file.

Each row of the matrix contains additional information such as the type, polarity and context of the layer.

The matrix defines the physical order of the layers and the relation of drill layers (through, blind, buried, and so forth). A product model can contain only one matrix file.



Example of a Matrix File

```
STEP {
COL=1
ID=67890
NAME=PCB
}
STEP {
COL=2
NAME=PANEL
}
...
LAYER {
ROW=1
CONTEXT=BOARD
TYPE=COMPONENT
ID=123456
NAME=COMP_+_TOP
POLARITY=POSITIVE
START_NAME=
END_NAME=
OLD_NAME=
ADD_TYPE=
COLOR=606090
}
LAYER {
ROW=2
CONTEXT=BOARD
TYPE=SILK_SCREEN
ID=123457
NAME=SST
OLD_NAME =
POLARITY=POSITIVE
REF=123458
START_NAME=
END_NAME=
OLD_NAME=
ADD_TYPE=
COLOR=606090
}
...
LAYER {
    ROW=10
    CONTEXT=BOARD
    TYPE=SIGNAL
    ID=123458
    NAME=top
    POLARITY=POSITIVE
    FORM=RIGID
    START_NAME=
    END_NAME=
    OLD_NAME=
    ADD_TYPE=
    COLOR=0
}
LAYER {
    ROW=11
    CONTEXT=BOARD
    TYPE=DIELECTRIC
    ID=123459
```

```
NAME=DIELECTRIC_4
POLARITY=POSITIVE
DIELECTRIC_TYPE=CORE
DIELECTRIC_NAME=FR4 CORE Material
FORM=RIGID
CU_TOP=123458
CU_BOTTOM=123460
START_NAME=
END_NAME=
OLD_NAME=
ADD_TYPE=
COLOR=0
}
LAYER {
  ROW=12
  CONTEXT=BOARD
  TYPE=SIGNAL
  ID=123460
  NAME=signal_2
  POLARITY=POSITIVE
  FORM=RIGID
  START_NAME=
  END_NAME=
  OLD_NAME=
  ADD_TYPE=
  COLOR=0
}
...
LAYER {
  ROW=16
  CONTEXT=BOARD
  TYPE=DRILL
  NAME=DRILL_4_4
  POLARITY=POSITIVE
  START_NAME=sig4
  END_NAME=sig5
  OLD_NAME=
}
```

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Fields in the STEP Array of a Matrix File

These are the fields in the STEP array of the matrix file:

Field	Explanation
COL	The number of the column in the matrix. Column numbers must be unique positive numbers (1 and above). Gaps are allowed between columns.
ID	A unique ID for the step definition in the matrix (optional). See “ Unique ID ” on page 30.
NAME	A legal entity name for the step. Each named step must have a step entity defined under the <i>steps</i> directory of the product model. See “ Legal Entity Names ” on page 22.

Fields in the LAYER Array of a Matrix File

These are the fields in the LAYER array of the matrix file:

Field	Explanation
ROW	The number of the row in the matrix. Rows must be unique positive numbers (1 and above). Order is not important, and the numbering need not be sequential. Gaps are allowed between row numbers. See “ Recommended Buildup ” on page 69 for a suggested buildup of base type layers.
CONTEXT	The layer context must be one of these values: BOARD — A layer that participates in the actual board production. MISC — Any other layer that is used for drawings, testing, and so forth.

Field	Explanation
TYPE	<p>The type of layer.</p> <p>For some layer types, sub-layer types can be supplied in the ADD_TYPE field. See “Layer Subtypes” on page 70.</p> <p>The layer type must be one of these values:</p> <ul style="list-style-type: none"> • SIGNAL — A layer used for regular signal transfer. • POWER_GROUND — A plane layer, used for power or ground signals. • DIELECTRIC — A dielectric layer that separates two copper layers. • MIXED — A combination of a signal and a plane layer. • SOLDER_MASK — A layer used for solder mask application. • SOLDER_PASTE — A layer used for depositing solder paste for assembly. • SILK_SCREEN — A layer used for application of text legend. • DRILL — A layer used to produce drill programs. Additional information pertaining to type of drill layer can optionally be applied to this base type. See “Layer Subtypes” on page 70. • ROUT — A layer used to produce rout program. • DOCUMENT A layer used for drawings, testing, auxiliary processes, and so forth. • COMPONENT — A layer containing components locations and outlines. • MASK — A layer containing additional information used as the base type for all mask types. See “Layer Subtypes” on page 70. • CONDUCTIVE_PASTE — A layer used to represent the depositing of conductive materials.
ID	<p>A unique ID for the layer definition in the matrix (optional).</p> <p>See “Unique ID” on page 30.</p>
NAME	<p>A legal entity name for the layer. Each named layer MUST have a layer entity defined under the layers directory of each step in the product model, otherwise the product model might be unreadable. See “Legal Entity Names” on page 22.</p>
OLD_NAME	<p>Previous name of the layer. When this field has a value it means that a matrix layer has been renamed and this value is its old name. If the field is blank it means the layer has not been renamed.</p>

Field	Explanation
POLARITY	<p>POSITIVE or NEGATIVE</p> <p>Controls whether the graphic representation of features is to be considered to be solid.</p> <p>In ODB++ format, for POSITIVE copper layers—like SIGNAL, POWER_GROUND, MIXED—the features represent copper; for SOLDER_PASTE layers, features represent paste.</p> <p>For NEGATIVE layers, features represent laminate. This is most commonly used on POWER_GROUND layers where pad features represent clearance, and background content is copper.</p> <p>One exception is the SOLDER_MASK and MASK layers when polarity is required to be POSITIVE and features represent clearances in the physical mask.</p> <p>COMPONENT, SILKSCREEN, DRILL, ROUT, and DOCUMENTATION layers should always have POSITIVE polarity. This polarity value in the matrix is in no way connected to the intended artwork generation polarity.</p>
DIELECTRIC_TYPE	<p>Applies to layers of type DIELECTRIC to define the purpose behind the material. (optional) (default = NONE)</p> <ul style="list-style-type: none"> • NONE — Not defined. • PREPREG — Material that is constructed with fiberglass impregnated with resin. The resin is pre-dried, but not hardened, and when heated, flows to adhere to neighboring material. • CORE — Material that is pre-pressed layers according to a pattern of copper foil - prepreg - copper foil.
DIELECTRIC_NAME	<p>A text field that is intended to carry the material name as reference in the design application. (optional)</p>
FORM	<p>Defines the layer as ridge or flexible. (optional) (default = RIGID)</p> <ul style="list-style-type: none"> • RIGID — Layer is defined as rigid. • FLEX — Layer is defined as flexible. <p>Layers of the subtype SIGNAL_FLEX, PG_FLEX and MIXED_FLEX have a default FORM = FLEX.</p> <p>Layers of type DIELECTRIC are to be defined as RIGID or FLEX.</p>
CU_TOP	<p>Used with layer type DIELECTRIC to indicate that a copper board layer is to be manufactured on top of the DIELECTRIC material.</p> <p>The value is the UID of the layer being referenced. This field would be used as part of a DIELECTRIC_TYPE=CORE definition. (optional)</p>

Field	Explanation
CU_BOTTOM	<p>Used with layer type DIELECTRIC to indicate that a copper board layer is to be manufactured on bottom of the DIELECTRIC material.</p> <p>The value is the UID of the layer being referenced. This field would be used as part of a DIELECTRIC_TYPE=CORE definition. (optional)</p>
REF	<p>Establishes a connection for layers within the matrix for the layer types SOLDER_MASK, SOLDER_PASTE, SILK_SCREEN, MASK, or CONDUCTIVE_PASTE with any layer whose type is SIGNAL, POWER_GROUND, or MIXED.</p> <p>This relationship is established through the use of the REF directive, and is to contain the UID of the reference layers. Only layers of type SOLDER_MASK, SOLDER_PASTE, SILK_SCREEN, MASK, or CONDUCTIVE_PASTE can have this tag.</p> <p>For example, consider a build sequence where a solder mask is being applied to an inner layer of a board. Within ODB++ itself, the only relationship between a solder mask layer and the applied outer copper layer is the position of the solder mask in the matrix. If the solder mask layer was to be positioned within a matrix with copper above and below, either could be viewed as the recipient of the mask. The Related Layers (ref) tag would be used to establish the connection to the appropriate copper layer. (optional)</p>
START_NAME, END_NAME	<p>These fields are active only for drill and rout layers. They specify the span of the drill or rout, in case it is partial (for example, blind or buried via layers). Each field must be a valid board layer name.</p> <p>When the fields are empty, START_NAME is assumed to be the first board layer (that is not a drill or rout layer) and END_NAME is assumed to be the last board layer (that is not a drill or rout layer).</p> <p>The START_NAME and END_NAME are based on the name of the board layers in sequence from the top of the matrix to the bottom, regardless of actual drill direction. The layer attribute .drill_layer_direction is used to specify actual drill direction from the 'top to bottom' or 'bottom to top'. Default drill direction is 'top to bottom'. Therefore, blind drills or backdrills coming up from the bottom would actually start from within the matrix and end on the bottom, and the attribute .drill_layer_direction would be 'bottom2top'.</p> <p>See “ODB++ System Attributes - Alphabetical List” on page 215.</p>

Field	Explanation
ADD_TYPE	Contains the layer subtype name. (optional) For example: <ul style="list-style-type: none">• PUNCH for layers with base type ROUT.• COVERLAY for layers with base type SOLDER_MASK.• BACKDRILL for layers with base type DRILL.• SILVER_MASK for layers with base type CONDUCTIVE_PASTE.• WIRE_BONDING for layers with base type MASK. See “ Layer Subtypes ” on page 70.
COLOR	RGB defines the recommended color for display of this layer in the layer list. The representation is created using a percentage of red, green and blue. The syntax is COLOR=RRGGBB where RR, GG and BB are numbers between 00-99. For example, COLOR=304050. Default=0, indicating no preference. (optional)

Recommended Buildup

The ROW element represents the position of the layers in the buildup of the board.

Mask and dielectric layers related to any of the base layers should be placed above and below the relevant layers, as in the actual buildup.

Layer Type	Recommended Buildup of Base Type Layers
physical layers	<ul style="list-style-type: none">• component (top)• solder paste (top)• silk screen (top)• solder mask (top)• all copper layers as ordered in the step• solder mask (bottom)• silk screen (bottom)• solder paste (bottom)• component (bottom)

Layer Type	Recommended Buildup of Base Type Layers
drill layers	<p>Drill layers according to top to bottom sequence and depth. For example:</p> <ul style="list-style-type: none"> • Drill penetrating the top layer and extending to the greatest depth. • Drill penetrating the top layer and extending to the second greatest depth, and so forth, until all drills from the top layer are represented. • Drill beginning at the second layer and extending to the greatest depth. • Drill beginning at the second layer and extending to the second greatest depth, and so forth, until all drills from the second layer are represented. • Continuing until all drills are represented by a layer according to the initial point of penetration and the depth.
rout layer	Rout layer.
documentation, misc layers	Documentation or Misc layer.

Layer Subtypes

For some of the base layer types assigned in the TYPE field of the LAYER array of the *matrix* file, you can assign a layer subtype in the ADD_LAYER field. The tables below list the layer subtypes permitted for the different base layer types.

Layer Subtypes for General Needs

These layer subtypes support general needs in the representation of product models:

Layer Subtype ADD_LAYER	Base Type TYPE	Description
PUNCH	ROUT	Pattern to be punched by a die-cut fixture.

Layer Subtypes to Support Backdrill and Dual Diameter Drill

These layer subtypes support the possible unique needs of drill representation in product models. They are subtypes of the DRILL base type:

Layer Subtype ADD_LAYER	Base Type TYPE	Description
BACKDRILL	DRILL	Represents a backdrill procedure where the plating within a hole is removed from the unused portion of the matrix using a drill hole slightly larger than the original. This removes the connection from one side of the PCB.
DUAL_DIAMETER	DRILL	Represents a condition prior to plating where a slightly larger hole is drilled part way through the matrix at the same location as an existing hole.

Layer Subtypes to Support Embedded Resistors and Capacitors

These layer types support the unique needs of product models containing embedded resistors and embedded capacitors. They are layer subtypes of the MASK base type:

Layer Subtype ADD_LAYER	Base Type TYPE	Description
EMBEDDED_R	MASK	Feature shapes on the layer represent embedded resistors.
EMBEDDED_C	MASK	Feature shapes on the layer represent embedded capacitors.

Layer Subtypes to Support Flex/Rigid Flex Manufacturing

These layer types support the unique needs of Flex/Rigid Flex product models. They are subtypes of the indicated base type:

Layer Subtype ADD_LAYER	Base Type TYPE	Description
COVERLAY	SOLDER_MASK	Clearances of a coverlay layer.
COVERCOAT	SOLDER_MASK	Clearances of a covercoat layer.
STIFFENER	MASK	Shapes and locations where stiffener material is placed on the PCB.
BEND_AREA	MASK	For labeling areas on the PCB bent when the PCB is in use.

Layer Subtype ADD_LAYER	Base Type TYPE	Description
FLEX_AREA	MASK	Stores the geometries of the flex portions of the board.
RIGID_AREA	MASK	Stores the geometries of the rigid portions of the board.
PSA	MASK	Shapes and locations where PSA (Pressure Sensitive Adhesive) material is placed on the PCB.
AREA	DOCUMENT	Area definition.
SIGNAL_FLEX	SIGNAL	Signal (copper) layer on flex laminate. Used to distinguish from signal on rigid laminate in rigid-flex boards.
PG_FLEX	POWER_GROUND	Power and ground (copper) layer on flex laminate. Used to distinguish from power and ground layer on rigid laminate in rigid-flex boards.
MIXED_FLEX	MIXED	Mixed copper layer—a layer containing both power/ground planes and regular signal pads or traces—on flex laminate. Used to distinguish from a Mixed copper layer on rigid laminate in a rigid-flex board.
DRAWING	DOCUMENT	Drawing layer definition.
PLATING_MASK	MASK	Defines which features in the adjacent copper layer should be plated.
IMMERSION_MASK	MASK	Defines which features are to be covered during immersion in the gold process.
OSP_MASK	MASK	Defines which features are to be covered with OSP finish.
SILVER_MASK	CONDUCTIVE_PASTE	Defines the silver mask of the adjacent copper layer.
CARBON_MASK	CONDUCTIVE_PASTE	Defines the location where carbon ink is applied to copper layers.

Layer Subtype to Support Wire Bonding

This layer type supports wire bonding. It is a subtypes of the MASK base type:

Layer Subtype ADD_LAYER	Base Type TYPE	Description
WIRE_BONDING	MASK	<p>Wire bond connections are stored in separate layers for connections at the top and bottom sides, named <code>wire_bond+_top</code> and <code>wire_bond+_bot</code>.</p> <p>In a wire bond layer, die bumps (pins of source components) are represented by pads bearing attributes <code>.net_name</code>, <code>.comp_name</code>, and <code>.pin_name</code> (used as a link to the netlist file).</p> <p>Wire bonds are represented by lines bearing attribute <code>.bonding_profile</code>. The value of this attribute specifies the bonding order.</p> <p>Direct connection of die bump to copper pad (for flip chip) is represented by lines of zero length.</p>

Example of a Matrix File Defining a Wire Bond Layer

These matrix file lines define a layer containing wire bond connections.

```
LAYER {  
    ROW=1  
    CONTEXT=BOARD  
    TYPE=MASK  
    NAME=WIRE_BOND+_TOP  
    POLARITY=POSITIVE  
    START_NAME=  
    END_NAME=  
    OLD_NAME=  
    ADD_TYPE=WIRE_BONDING  
    COLOR=9999  
    ID=6190  
}
```

Example of a Matrix File Defining Layer Subtypes for Flex/Rigid Flex Manufacturing

These matrix file lines define layers with layer subtypes SILVER_MASK, COVERLAY, PG_FLEX, MIXED_FLEX, AREA, and PUNCH:

```
LAYER {  
    ROW=2  
    CONTEXT=BOARD  
    TYPE=MASK  
    NAME=SILVER_TOP  
    POLARITY=POSITIVE  
    START_NAME=  
    END_NAME=  
    OLD_NAME=MODPNL.46  
    ADD_TYPE=SILVER_MASK  
    COLOR=909098  
}  
LAYER {  
    ROW=3  
    CONTEXT=BOARD  
    TYPE=SOLDER_MASK  
    NAME=CVL1  
    POLARITY=POSITIVE  
    START_NAME=  
    END_NAME=  
    OLD_NAME=  
    ADD_TYPE=COVERLAY  
    COLOR=208020  
}  
LAYER {  
    ROW=9  
    CONTEXT=BOARD  
    TYPE=POWER_GROUND  
    NAME=L5  
    POLARITY=POSITIVE  
    START_NAME=  
    END_NAME=  
    OLD_NAME=PG5  
    ADD_TYPE=PG_FLEX  
    COLOR=856750  
}  
LAYER {  
    ROW=10  
    CONTEXT=BOARD  
    TYPE=MIXED  
    NAME=L6  
    POLARITY=POSITIVE  
    START_NAME=  
    END_NAME=  
    OLD_NAME=MODPNL.06  
    ADD_TYPE=MIXED_FLEX  
    COLOR=948775  
}  
LAYER {  
    ROW=21  
    CONTEXT=BOARD
```

```
    TYPE=DOCUMENT
    NAME=STIFFENER1_AREA
    POLARITY=POSITIVE
    START_NAME=
    END_NAME=
    OLD_NAME=
    ADD_TYPE=AREA
    COLOR=994171
}
LAYER {
    ROW=10
    CONTEXT=MISC
    TYPE=ROUT
    NAME=ADH-PUNCH_L2-L3
    POLARITY=POSITIVE
    START_NAME=
    END_NAME=
    OLD_NAME=
    ADD_TYPE=PUNCH
    COLOR=757575
}
```

misc (Miscellaneous)

These files relate to the misc entity.

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misc/attrlist (Product Model Attribute List)

This file contains the values for system attributes and user-defined attributes assigned to a product model. Only attributes that have been defined are stored in the product model.

You can provide *attrlist* files at these levels: product model, symbol, wheel, step, layer.

attrlist (Attributes Used in Product Model)	
Type	Structured Text
Compression	None
Path	<product_model_name>/misc/attrlist
UNITS	The UNITS directive is required.

System attributes that can be placed in this file are listed with Entity = Product Model in the attribute description. See “[System Attributes](#)” on page 215.



The file contains lines of this form: <attribute> = <value>

Example of a product model attrlist file

System attribute names begin with a dot. The attribute connector in this example is a user-defined attribute, and therefore does not begin with a dot. For a list of system attributes defined with Entity = Product Model, see “[System Attributes](#)” on page 215.

```
UNITS=INCH
.customer = abc
connector = no
target = no
```

misc/last_save (Last Time Product Model Saved)

This file is optional. It is written each time a save operation is performed on a product model. It records the time of the save operation.

last_save (Last Time Product Model Saved)	
Type	Line Record Text
Compression	None
Path	<product_model_name>/misc/last_save
UNITS	The UNITS directive is not relevant for the <i>last_save</i> file.

The file consists of a single line that contains the timestamp in format `yyyymmdd.hhmmss`.



Example of the last_save file

```
20141224.183210
```

misc/info (Basic Product Model Information)

This file records basic information about the product model. It is written each time a save operation is performed.

info (Basic Product Model Information)	
Type	Line Record Text
Compression	None
Path	<product_model_name>/misc/info
UNITS	The UNITS directive is required.

The UNITS directive in this file governs all product model units unless specifically overridden within the create file or element declaration. See “[Units of Measurement](#)” on page 23.



This information is stored in the *info* file:

Field	Explanation
PRODUCT_MODEL_NAME	Legal name of the product model.
ODB_VERSION_MAJOR	Major version designation such as 8 in Version 8.0, expressed as a numeric string. This can provide the application with a way to verify compatibility.
ODB_VERSION_MINOR	Minor version designation such as 0 in Version 8.0, expressed as a numeric string.
ODB_SOURCE	Source of data, typically a CAD/EDA system name of up to 500 characters.
CREATION_DATE	Creation date in the format yyyyymmdd.hhmmss.
SAVE_DATE	Save date in the format yyyyymmdd.hhmmss.
SAVE_APP	Name and number of the application in which the product model was saved, along with the currently running software version in up to 100 characters.
SAVE_USER	Login name of the user saving the file, in up to 50 characters (optional).
UNITS	Units used by default for this product model. (UNITS=MM INCH).
MAX_UID	The largest numerical unique ID in the product model (optional). See “ Unique ID ” on page 30.

Example of the info file

```
UNITS=MM
PRODUCT_MODEL_NAME=k10025_cd2
ODB_VERSION_MAJOR=8
ODB_VERSION_MINOR=0
ODB_SOURCE=Expedition
CREATION_DATE=20110727.091213
SAVE_DATE=20110727.091230
SAVE_APP=Valor NPI 9.2
SAVE_USER=mikel
MAX_UID=57394
```

misc/metadata.xml (Metadata)

Product description information is provided in a file named *metadata.xml*, stored in the *misc* directory of the product model.

metadata (Metadata)	
Type	XML
Compression	None
Path	<product_model_name>/misc/metadata.xml
UNITS	The UNITS directive is not relevant for the <i>metadata.xml</i> file.

The purpose of metadata is to support manufacturing process-cost calculation, and the generation of the Manufacturing Product Definition (MPD) during the early stage of the New Product Introduction (NPI) process. This data is made available immediately, without needing to process the ODB++ product model.



The file is not case sensitive.

See “[Metadata Example](#)” on page 312.

Data is added to the metadata as the product model moves through the flow processes.

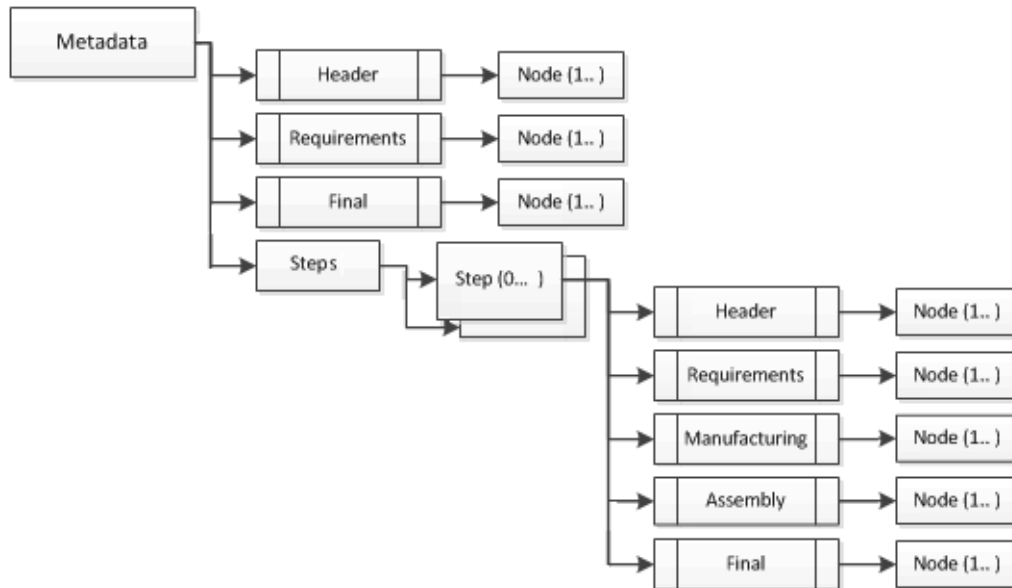
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Structure of the Metadata File

A metadata file can contain several types of element.

Element	Explanation
metadata section	<p>The metadata is divided into sections that indicate the type of metadata:</p> <ul style="list-style-type: none">• Header• Requirements• Manufacturing• Assembly• Final <p>Metadata that applies to the product model is placed in metadata sections at the top level of the hierarchy.</p> <p>Metadata that applies to a specific step is placed in metadata sections that are child elements of a step section.</p> <p>See “Metadata Sections” on page 81.</p>
steps section	<p>The steps section contains one or more step sections.</p> <p>This is the syntax of the steps element:</p> <pre><Steps description = “Steps”> </Steps></pre> <p>The description is optional.</p>
step section	<p>The start-tag of each step section indicates the name of the step.</p> <p>Between the start-tag of the step and its end-tag, are metadata sections containing metadata that applies to that step.</p> <p>This is the syntax of the step element:</p> <pre><step name="nnn" description="ddd" > </step></pre> <p>The description is optional.</p>
node	<p>These elements contain the metadata. Each node element must be placed in the appropriate metadata section.</p> <p>See “Metadata Types” on page 82.</p> <p>See “Attributes of a Metadata Node” on page 82.</p>
classify_by	<p>Some nodes can contain be classified by one or more levels of classes.</p> <p>See “Collective Data” on page 83.</p>

This illustrates the structure of a metadata file:



Metadata Sections

The metadata is divided into sections that indicate the type of metadata.

Some sections can be specified at the level of the product model, and some sections can be specified only in a step section of the file.

The information that can be specified in each section is listed in “[Metadata Content](#)” on page 300. For each node, there is an indication of whether the node can be specified at the product model level or at the step level:

Section	Explanation	Level	Content
Header	General information about the product or the step.	product model or step	“ Header Metadata Section ” on page 300
Requirements	Overall requirements specified by the designer.	product model or step	“ Requirements Metadata Section ” on page 301
Manufacturing	Manufacturing information.	step	“ Manufacturing Metadata Section ” on page 306
Assembly	Assembly information.	step	“ Assembly Metadata Section ” on page 310
Final	Quality assurance and delivery information.	product model or step	“ Final Metadata Section ” on page 311

The metadata section elements have this syntax. The description attribute is optional.

Element	Syntax
Header	<code><header description="ddd" /></code> <code></header></code>
Requirements	<code><requirements description="ddd" /></code> <code></requirements></code>
Manufacturing	<code><manufacturing description="ddd" /></code> <code></manufacturer></code>
Assembly	<code><assembly description="ddd" /></code> <code></assembly></code>
Final	<code><final description="ddd" /></code> <code></final></code>

Metadata Types

Each value stored in the metadata file is of one of these data types:

Type	Description
Boolean	A value of either yes or no.
Integer	A value expressed as an integer.
Float	A value expressed as a decimal number. A node of this type can be of one of these unit types: <ul style="list-style-type: none">• distance — Represents distance.• size — Represents the size of a feature.• temperature — Represents temperature.• area — Represents area.
Text	Text strings of printable ASCII characters.
Option	One of the legal values.
TextWithOptions	One of the suggested values or another text string.

Attributes of a Metadata Node

Metadata is specified in node statements.

It has this syntax:

```
<node name="nnn", value="vvv", units="uuu", layer="lll", display="ddd" />
```

See “[Metadata Content, Example, and Schema](#)” on page 299.

These are the attributes of the node element:

Attribute	Description	Legal Values	Required
name	Name of the information.	A name in “ Metadata Content ” on page 300.	required
value	A value stored for future reference by its metadata content name.	Legal values based on the type of content stored.	
units	Units of measure. Permitted values for units correspond to those defined in “ Units of Measurement ” on page 23.	distance — inch or mm size — inch or mm temperature — fahrenheit or centigrade area — square mm or square inch	Required only for float data.
layer	The name of the layer to which the name/value pair is assigned.	A layer name located in the product model matrix.	optional
display	Suggested text for the application display.	ASCII text characters.	optional

Collective Data

In some cases, metadata content can represent a collection of similar data—for example, the number of components classified by type. In such a case, `classify_by` elements are included in the file.

This is the syntax:

```
<classify_by name="nnn", value="vvv", units="uuu", layer="lll",  
display="ddd" />
```

Classification is recursive, and can include an additional level of classification. component_count can be classified by two parameters: layer and technology. The corresponding segment of the metadata file looks like this:

```
<node name=component_count value= 30 display=Component Count >
  <classify_by name=top value=10 display="Components in Top Layer:" >
    <classify_by name=bga value=5 />
    <classify_by name=axial value=5 />
  </classify_by>
  <classify_by name=Layer3 value=10 display="Components in Inner Layer 3"
>
  <classify_by name=bga value=5 />
  <classify_by name=axial value=5 />
</classify_by>
  <classify_by name=bottom value=10 display="Components in Bottom Layer:"
>
  <classify_by name=bga value=5 />
  <classify_by name=axial value=5 />
</classify_by>
</node>
```

This is an example report that could be generated from the component_count segment.

	Layer	Technology	Value
Component Count	Total for all layers		30
Components in layer	Top Layer		10
		bga	5
		axial	5
Components in layer	Inner Layer 3		10
		bga	5
		axial	5
Components in layer	Bottom Layer		10
		bga	5
		axial	5

This metadata content requires classification:

Name	Display Name	Classified by
component_count	Components per Step	layer, technology
number_of_nets_with_probes	Number of Nets with Probes	layer, size
number_of_fiducials	Number of Fiducials	layer
total_number_of_smd_pads	Total Number of SMD Pads	layer
number_of_test_points	Number of Test Points	side

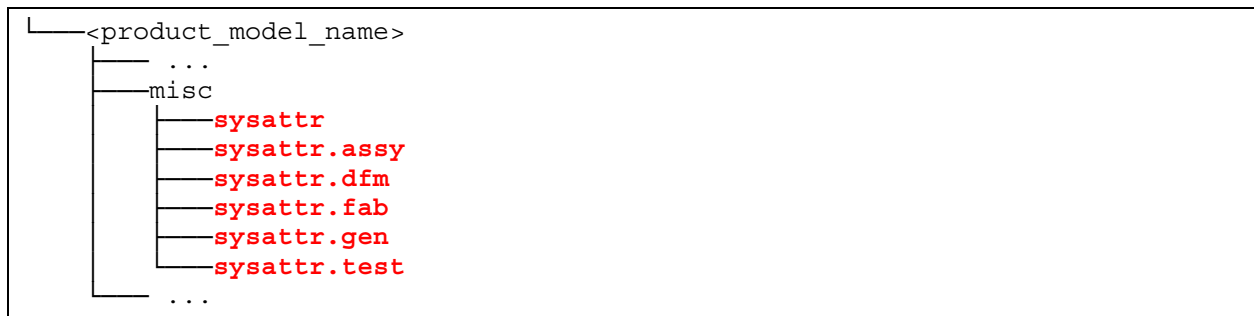
Name	Display Name	Classified by
number_of_drill_holes	Number of Drill Holes	layer
number_of_tooling_holes	Number of Tooling Holes	layer
number_of_un-connected_nets	Number of Unconnected Nets	layer
number_of_single_pin_nets	Number of Single Pin Nets	layer
number_of_multi_pin_nets	Number of Multi-pin Nets	layer
cad_package_analysis	CAD Package Analysis	layer, CAD package, pin_count and pitch

misc/sysattr.* (Attribute Definition)

Attribute definition files for all attributes in the product model are stored under `<product_model_name>/misc`. They all have the same syntax. Attributes starting with the dot (.) character are system attributes (some system attributes must be defined for certain processes, such as analysis). User-defined attributes cannot have the dot character before their name.

sysattr, sysattr.dfm, sysattr.fab, sysattr.assy, sysattr.test, sysattr.gen	
Type	Line Record Text
Compression	None
Path	<code><product_model_name>/misc/sysattr</code> <code><product_model_name>/misc/sysattr.dfm</code> <code><product_model_name>/misc/sysattr.fab</code> <code><product_model_name>/misc/sysattr.assy</code> <code><product_model_name>/misc/sysattr.test</code> <code><product_model_name>/misc/sysattr.gen</code>
UNITS	The UNITS directive is required.

Every attribute definition file contains a list of definitions, defined at the time the product model was created. It is read each time the product model is opened.



For a discussion of ODB++ attributes, see “[ODB++ Attributes](#)” on page 27.

For a discussion of user defined attributes, see “[misc/userattr \(User Attribute Definition\)](#)” on page 92.

Attribute Type	Description
BOOLEAN Attribute Definition	Attributes that have values of either YES or NO.

Attribute Type	Description
TEXT Attribute Definition	Attributes that are text strings have values comprised of printable ASCII characters, and with a length range specified by the attribute definition.
OPTION Attribute Definition	Attributes that have values limited to a list of options supplied as part of the attribute definition.
INTEGER Attribute Definition	Attributes that have a numerical integer value within the range defined by the attribute definition.
FLOAT Attribute Definition	Attributes that have numeric values that can also contain decimal notation within the range defined in the attribute definition.

BOOLEAN Attribute Definition

Attributes that have values of either YES or NO.

Field	Explanation
NAME	Name of the attribute.
PROMPT	The name used on screen when this attribute is displayed (Optional).
ENTITY	The entities for which this attribute is applicable. A semicolon (;) separated list of entity types: JOB, STEP, SYMBOL, LAYER, BUILDUP, WHEEL, FEATURE, COMPONENT, or PACKAGE.
GROUP	Name of the class to which this attribute belongs. This could be DFM Analysis, Product, Process: Fabrication, Assembly, Test, Generic, or other. See “ Attribute Classes ” on page 27.
DEF	The default value of the attribute, if no value is specified. If the DEF keyword is missing or not defined, the suggested default is NO.

Example

```

BOOLEAN
{
  NAME      = .string_mirrored
  ENTITY    = FEATURE
  DEF       = NO
  GROUP     = Fabrication
  PROMPT    = String Mirror
}

```

TEXT Attribute Definition

Attributes that are text strings have values comprised of printable ASCII characters, and with a length range specified by the attribute definition.

Field	Explanation
NAME	Name of the attribute.
PROMPT	The name used on screen when this attribute is displayed (Optional).
OPTIONS	A semicolon (;) separated list of options. Unlike other Options lists, the text attribute is used to provide a selection of the most commonly used values.
MIN_LEN	Minimum number of characters allowed in the value of the attribute.
MAX_LEN	Maximum number of characters allowed in the value of the attribute.
ENTITY	The entities for which this attribute is applicable. A semicolon (;) separated list of entity types: JOB, STEP, SYMBOL, LAYER, BUILDUP, WHEEL, FEATURE, COMPONENT, or PACKAGE.
GROUP	Name of the class to which this attribute belongs. This could be DFM Analysis, Product, Process: Fabrication, Assembly, Test, Generic, or other. See “ Attribute Classes ” on page 27.
DEF	The default value of the attribute, if no value is specified. If the DEF keyword is missing or not defined, the suggested default is an empty string.

Example

```
TEXT
{
  NAME      = .string
  OPTIONS   =
  ENTITY    = FEATURE
  MIN_LEN   = 0
  MAX_LEN   = 1000
  GROUP     = Feature
  DEF       =
  PROMPT    = Copper Text String
}
```

OPTION Attribute Definition

Attributes that have values limited to a list of options supplied as part of the attribute definition.

Field	Explanation
NAME	Name of the attribute.
PROMPT	The name used on screen when this attribute is displayed (Optional).
OPTIONS	A semicolon (;) separated list of options.
DELETED	A semicolon (;) separated list of the values YES and NO. Only an index number to the list of options in the OPTIONS field is stored within the format. Therefore, the removal of an existing option is not allowed. The list of corresponding YES or NO values indicates whether an option is available for use. A value of YES indicates that the corresponding OPTIONS value is to be ignored.
ENTITY	The entities for which this attribute is applicable. A semicolon (;) separated list of entity types: JOB, STEP, SYMBOL, LAYER, BUILDUP, WHEEL, FEATURE, COMPONENT, or PACKAGE.
GROUP	Name of the class to which this attribute belongs. This could be DFM Analysis, Product, Process: Fabrication, Assembly, Test, Generic, or other. See “ Attribute Classes ” on page 27.
DEF	The default value of the attribute, if no value is specified. If the DEF keyword is missing or not defined, the suggested default is the first value in the OPTIONS list.

Example

In this example, option both is defined as being logically deleted.

```
OPTION {
  NAME=.viacap_layer
  PROMPT=Via Capping on Layer
  OPTIONS=top;bottom;both;none
  DELETED=NO;NO;YES;NO
  ENTITY=step
  DEF=none
  GROUP=Custom
}
```

INTEGER Attribute Definition

Attributes that have a numerical integer value within the range defined by the attribute definition.

Field	Explanation
NAME	Name of the attribute.

Field	Explanation
PROMPT	The name used on screen when this attribute is displayed (Optional).
MIN_VAL	Minimum value for the integer attribute.
MAX_VAL	Maximum value for the integer attribute.
ENTITY	The entities for which this attribute is applicable. A semicolon (;) separated list of entity types of: JOB, STEP, SYMBOL, LAYER, BUILDUP, WHEEL, FEATURE, COMPONENT, or PACKAGE.
GROUP	Name of the class to which this attribute belongs. This could be DFM Analysis, Product, Process: Fabrication, Assembly, Test, Generic, or other. See “ Attribute Classes ” on page 27.
DEF	The default value of the attribute, if no value is specified. If the DEF keyword is missing or not defined, the suggested default is MIN_VAL.

Example

```
INTEGER {  
  NAME      = .num_local_fiducials  
  ENTITY    = COMPONENT  
  DEF       = 0  
  MIN_VAL   = 0  
  MAX_VAL   = 20  
  GROUP     = DFx Component  
  PROMPT    = Number Local Fiducials Required  
}
```

FLOAT Attribute Definition

Attributes that have numeric values that can also contain decimal notation within the range defined in the attribute definition.

Field	Explanation
NAME	Name of the attribute.
PROMPT	The name used on screen when this attribute is displayed (Optional).
MIN_VAL	Minimum value for the float attribute.
MAX_VAL	Maximum value for the float attribute.
ENTITY	The entities for which this attribute is applicable. A semicolon (;) separated list of entity types of: JOB, STEP, SYMBOL, LAYER, BUILDUP, WHEEL, FEATURE, COMPONENT, or PACKAGE.

Field	Explanation
GROUP	Name of the class to which this attribute belongs. This could be DFM Analysis, Product, Process: Fabrication, Assembly, Test, Generic, or other. See “ Attribute Classes ” on page 27.
DEF	The default value of the attribute, if no value is specified. If the DEF keyword is missing or not defined, the suggested default is MIN_VAL.
UNIT_TYPE	DISTANCE, WEIGHT, TEMPERATURE, AREA, RESISTANCE, COPPER_WEIGHT, VOLTAGE, CURRENT. Determines the units used in accordance with the type of measurement. (Default = DISTANCE) See “ Units of Measurement ” on page 23.
UNITS	Default = NO_UNITS <ul style="list-style-type: none"> When UNIT_TYPE=DISTANCE — Possible values are INCH_MM or MIL_MICRONS. This affects the way the value is interpreted—inch or mil, millimeter or micron. When UNIT_TYPE=RESISTANCE — Possible values are OHM or NANO_OHM. This affects the way the value is interpreted—ohms or nano-ohms. (Default for RESISTANCE is OHM) <p>The UNITS field does not apply to other UNIT_TYPE values.</p> <p>You can use the UNITS line to specify the units in which the values of MIN_VAL and MAX_VAL are given. The way in which the UNITS line of the attribute is interpreted depends on the UNITS directive at the top of the file. See the examples.</p>

Example

```

FLOAT {
  NAME      = .local_fiducial_dist
  ENTITY    = COMPONENT
  MIN_VAL   = 0.0
  MAX_VAL   = 100.0
  UNITS     = INCH_MM
  PROMPT    = Search Distance for Local Fiducial
  GROUP     = Assembly
  DEF       = 50.0
}

```

Example: UNITS directive = MM and UNITS line = MIL_MICRON

In this example, MAX_VAL is interpreted as 100 micron. The directive UNITS=MM specifies that measurements in the file are given in metric units. The attribute definition contains the line

UNITS=MIL_MICRON, which specifies that if units of measurement are metric, the measurements are to be interpreted as microns.

```
UNITS=MM

...

FLOAT {
NAME=.spacing_reg
ENTITY=FEATURE
MIN_VAL=0.0
MAX_VAL=100.0
UNITS=MIL_MICRON
GROUP=DFx Feature
PROMPT=Spacing Required
DEF=25.0
}
```

Example: UNITS directive = INCH and UNITS line = MIL_MICRON

In this example, MAX_VAL is interpreted as 100 mil (0.1 inch). The directive UNITS=INCH specifies that measurements in the file are given in imperial units. The attribute definition contains the line UNITS=MIL_MICRON, which specifies that if units of measurement are imperial, the measurements are to be interpreted as mils.

```
UNITS=INCH

...

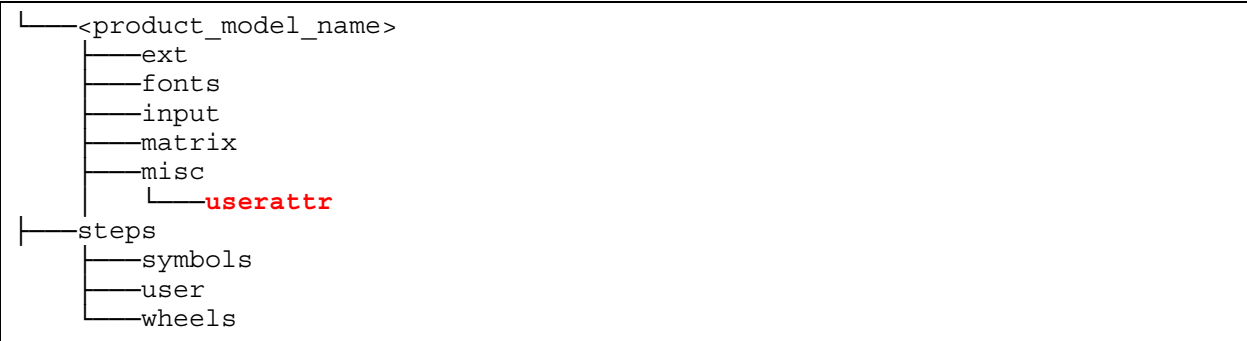
FLOAT {
NAME=.spacing_reg
ENTITY=FEATURE
MIN_VAL=0.0
MAX_VAL=100.0
UNITS=MIL_MICRON
GROUP=DFx Feature
PROMPT=Spacing Required
DEF=0.025
}
```

misc/userattr (User Attribute Definition)

User-defined attributes cannot have the dot character before their name.

userattr	
Type	Line Record Text
Compression	None
Path	<product_model_name>/misc/userattr
UNITS	The UNITS directive is required.

The user attribute definition file contains a list of definitions, defined at the time the product model was created. It is read each time the product model is opened.



The format of user attribute definitions is the same as the format of system attribute definitions. See “[misc/sysattr.* \(Attribute Definition\)](#)” on page 86.

For a discussion of ODB++ attributes, see “[ODB++ Attributes](#)” on page 27.

steps

Steps are multi-layer entities such as a single image, an assembly panel, a fabrication panel, or a fabrication coupon. Each step contains a collection of layers. Layers are two-dimensional sheets, containing graphics, attributes and annotation.

For information on the *steps* directory of the product model, see “[Step Entities](#)” on page 99.

symbols (User-Defined Symbols)

Symbols are single layer graphic entities that can be referenced from within any graphic layer in a step. ODB++ format can handle both standard symbols and user-defined symbols.

Standard symbols are rendered dynamically from their name. Standard symbols do not require any files. See “[Standard Symbols](#)” on page 36.

User-defined symbols require these files:

<symbol_name>/attrlist (Symbol Attribute List)	94
<symbol_name>/features (Symbol Features)	95

<symbol_name>/attrlist (Symbol Attribute List)

This file contains the values for system attributes and user-defined attributes assigned to a symbol.

You can provide *attrlist* files at these levels: product model, symbol, wheel, step, layer.

attrlist (Attribute List)	
Type	Structured Text
Compression	None
Path	<product_model_name>/symbols/<symbol_name>/attrlist
UNITS	The UNITS directive is required.

System attributes that can be placed in this file are listed with Entity = Symbol in the attribute description. See “[System Attributes](#)” on page 215.



The file contains lines of this form: <attribute> = <value>.

Example of an attrlist file for a Symbol

```

UNITS=INCH
.out_break = no
.out_scale = no
.break_away = no
.fill_dx = 0.100000
.fill_dy = 0.100000
.image_dx = -1.000000
.image_dy = -1.000000
.connector = no
.target = no
.component =
.comment =
.hole_type = plated
.serial_number = 15
  
```

<symbol_name>/features (Symbol Features)

Each user-defined symbol has a *features* file to define its shape.

features (Symbol Features)	
Type	Line Record Text
Compression	Yes
Path	<product_model_name>/symbols/<symbol_name>/features
UNITS	The UNITS directive is required.

The symbol features file describes the graphic shape of the symbol.



The file is similar in structure to the layer features file. See “<layer_name>/features (Graphic Features)” on page 170.

user (User)

This directory is the location to store user files.



wheels (Gerber and Tool Wheels)

Wheels are aperture tables used for the correct translation of Gerber 274D files and/or drill/rout files with external tool definitions. These files relate to the *wheels* entity of the product model:

<wheel_name>/attrlist (Wheel Attribute List)	96
<wheel_name>/dcodes (Dcodes)	96

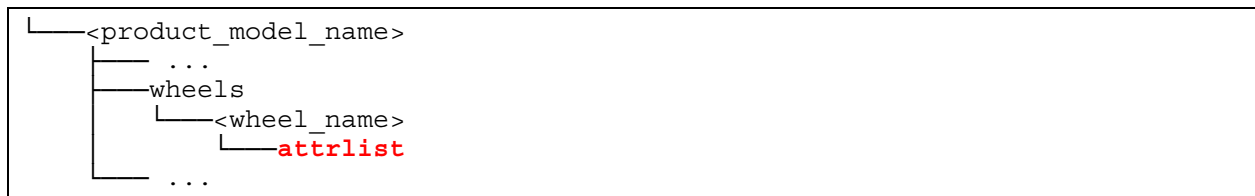
<wheel_name>/attrlist (Wheel Attribute List)

This file contains the values for system attributes and user-defined attributes assigned to a wheel.

You can provide *attrlist* files at these levels: product model, symbol, wheel, step, layer.

attrlist (Attributes Values)	
Type	Structured Text
Compression	None
Path	<product_model_name>/wheels/<wheel_name>/attrlist
UNITS	The UNITS directive is required.

System attributes that can be placed in this file are listed with Entity = Wheel in the attribute description. See “[System Attributes](#)” on page 215.



The file contains lines of this form: <attribute> = <value>

Example of a wheel attrlist file

```

UNITS=MM
comment=Mentor wheel
  
```

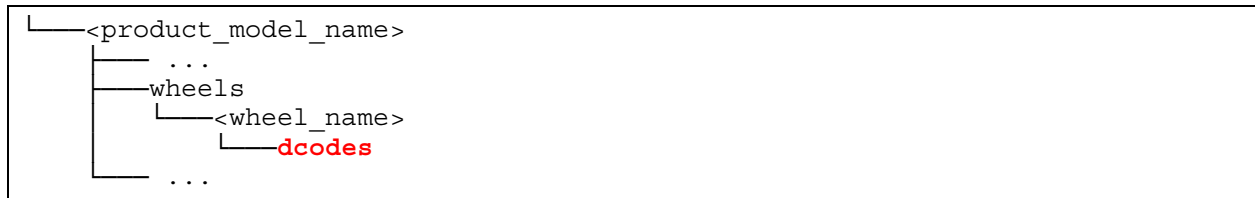
<wheel_name>/dcodes (Dcodes)

This file lists dcodes. A dcode is a Gerber dcode number or an Excellon tool number.

dcodes	
Type	Line Record Text

dcodes	
Compression	None
Path	<product_model_name>/wheels/<wheel_name>/dcodes
UNITS	The UNITS directive is not relevant for the <i>dcodes</i> file.

This file saves the wheel used during Gerber input for translation purposes. Once the file is processed, both the dcodes and Gerber file are no longer referenced.



Each line in the file has this format: dcode<n> <symbol_name> <angle> <mirror>

Field	Explanation
n	Dcode number.
symbol_name	Symbol name.
angle	Always 0.
mirror	Always no_mirror.

Example of a dcodes file

```

dcode10 r12 0 no_mirror
dcode11 r50 0 no_mirror
dcode12 r60 0 no_mirror
dcode13 r10 0 no_mirror
dcode14 r70 0 no_mirror
dcode15 r80 0 no_mirror
dcode17 r5 0 no_mirror

```


Chapter 4

Step Entities

Steps are multi-layer entities such as a single image, an assembly panel, a fabrication panel, or a fabrication coupon. Each step contains a collection of layers. Layers are two-dimensional sheets, containing graphics, attributes and annotation. Layers express physical board layers, mask layers, NC drill and rout layers and miscellaneous drawings. All steps in one product model have the same list of layers, even though the contents might be different.

A step is capable of referencing the content of another step, thereby graphically including its content. The referenced step must be within the product model. When this occurs, the layer content for the referenced step appears on the primary step. This process can be repeated any number of times. The most commonly used term for describing this capability is step and repeat, used to create fabrication and assembly panels. Within the primary step, feature display is first defined by the sequence within the referenced step's feature container, then the sequence the steps are added to the primary step, and finally the feature sequence as defined by the primary step's feature container. For more information about feature sequence, see “[Geometric Entities](#)” on page 39.

This section describes each element of the step entity.

<step_name>/attrlist (Step Attribute List)	100
<step_name>/boms (Bill of Materials)	101
<bom_name>/bom (Bill Of Materials)	101
<bom_name>/files (Source Files)	106
<step_name>/eda (Electronic Design Automation)	108
eda/data (EDA Data)	109
eda/shorts (Electrical Intention Short Net)	120
eda/hdi_netlist (HDI Netlist)	126
<step_name>/impedance.xml (Impedance)	132
Structure of the Impedance File	133
<step_name>/layers	134
<step_name>/netlists	135
cadnet/netlist (cadnet)	135
refnet/netlist (Reference)	141
<step_name>/profile (Outline Shape of Step)	141
<step_name>/stephdr (Step Header)	143
<step_name>/zones (Matrix Broken Into Sections)	145

<step_name>/attrlist (Step Attribute List)

This file contains the values for system attributes and user-defined attributes assigned to a step.

You can provide *attrlist* files at these levels: product model, symbol, wheel, step, layer.

attrlist (Attribute List)	
Type	Structured Text
Compression	None
Path	<product_model_name>/steps/<step_name>/attrlist
UNITS	The UNITS directive is required.

System attributes that can be placed in this file are listed with Entity = Step in the attribute description. See “[System Attributes](#)” on page 215.



The file contains lines of this form: <attribute> = <value>

Example of the attrlist file

In the example, comment is a user-defined attribute, so it does not begin with a dot.

```

UNITS=MM
.board_thickness=50
.out_drill_full = no
.out_drill_optional = no
.out_rout_optional = no
.fs_direction_top = left2right
.fs_direction_bottom = right2left
comment = Production Step
  
```

<step_name>/boms (Bill of Materials)

The *boms* directory of the step contains a directory for each BOM associated with the step. The name of the directory is the name of the BOM.

The directory for each BOM contains a file named *bom* and a directory named *files*.

See “[Component Variants](#)” on page 41.

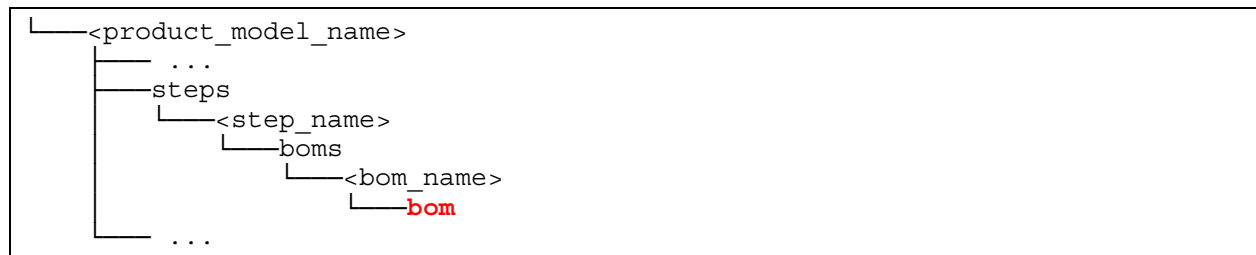
<bom_name>/bom (Bill Of Materials).....	101
<bom_name>/files (Source Files)	106

<bom_name>/bom (Bill Of Materials)

The BOM file describes the Bill of Materials for a board. It is a list of the components that can be used in assembling the electronic product.

bom	
Type	Line Record Text
Compression	None
Path	<product_model_name>/steps/<step_name>/boms/<bom_name>/bom
UNITS	The UNITS directive is not relevant for the <i>bom</i> file.

Each component contains a list of attributes and its uses or locations in the electronic product being assembled.



Each LNFILE line in the *bom* file indicates that source information for the preceding line is stored in the indicated file in the <bom_name>/files directory. The LNFILE line provides the line number and the file name. For example, LNFILE 5 Rev14.v1 indicates that information is stored in line 5 of file *Rev14.v1*.

The file ends with a FILE_END record.

The *bom* file contains these sections: HEADER, DESC_ALIASES, RS_CPN, CPN_MPN, CP.

HEADER Section

The header section of the *bom* file contains these parameters:

Parameter	Description
HEADER	Signals the start of the header section.
BRD	Board number.
REV	Revision.
HEADER_END	Signals the end of the header section.

DESC_ALIASES Section

The DESC_ALIASES section of the *bom* file provides aliases for CPN and MPN descriptions to enable terms to be displayed in the language of the product model creator.

Parameter	Description
DESC_ALIASES	Signals the start of the DESC_ALIASES section.
LANG	The language code of the product model creator: <ul style="list-style-type: none">• c — English.• ja — Japanese.• gb — Simplified Chinese.• big5 — Traditional Chinese.• ko — Korean.
INDEX	A number that provides the link between an alias and a description in the CP section. The index starts at 1 and increases. For example, an alias with an index of 3 corresponds to the third description (DSC) of every CPN in the CP section.
CPN or MPN	The alias for the CPN field or the MPN field in either English or a specified language.
DESC_ALIASES_END	Signals the end of the DESC_ALIASES section.

RD_CPN Section

The RD_CPN section of the *bom* file lists the Reference Designators and their matching Customer Part Numbers:

A LNFILE entry is saved for each REF and CPN.

Parameter	Description
RD_CPN	Signals the start of the RD_CPN section
REF	Reference designator name.
CPN	Customer part number.
RD_CPN_END	Signals the end of the RD_CPN section.

CPN_MPN Section

The CPN_MPN section of the *bom* file lists Customer Parts and their matching Manufacturer Parts

A LNFILE entry is saved for each CPN, MPN, and VND.

Parameter	Description
CPN_MPN	Signals the start of the CPN_MPN section.
CPN	Customer part number.
VPL_MPN	MPN from an external vendor part library corresponding to the original MPN (as determined in BOM Validation).
VPL_VND	Manufacturer from an external vendor part library corresponding to the original vendor (as determined in BOM Validation).
MPN	Manufacturer part number.
VND	Manufacturer (vendor) name.
QLF	Indicates whether the part (MPN+VND) is qualified for production: -1 — Not qualified. 0 — Unknown. 1 — Qualified.
CHS	Indicates whether this part is chosen from among the alternate parts for the CPN. Only one alternate can be designated as chosen.
CPN_MN_END	Signals the end of the CPN_MPN section.

CP Section

The CP section of the *bom* file lists Customer Part Numbers and their descriptions.

A LNFILE entry is saved for each CPN, IPN, DSC, and PKG.

Parameter	Description
CP	Signals the start of the CP section.

Parameter	Description
CPN	Customer part number.
IPN	Internal part number.
DSC	Unlimited number of descriptions.
PKG	CAD package name.
QNT	Reference designator quantity.
ITEM	Item number.
CP_END	Signals the end of the CP section.

Example of a bom file

```
# Header Parameters
HEADER
BRD
REV
HEADER_END

# Description Aliases
DESC_ALIASES
LANG fr
INDEX 1
CPN Cout
CPN Cost
INDEX 1
MPN Benefice
MPN Profit Margin
DESC_ALIASES_END

# Reference Descriptors and matching Customer Parts
RD_CPN
REF XTAL1
LNFILE 5 Rev14.v1
CPN 004-020-101
LNFILE 5 Rev14.v1

REF Y8
LNFILE 7 Rev14.v1
CPN 004-040-101
LNFILE 7 Rev14.v1

RD_CPN_END

# Customer Parts and Matching Manufacturer Parts
CPN_MPN
CPN 004-020-101
LNFILE 5 Rev14.v1
VPL_MPN
VPL_VND TOYOCOM
MPN TQC-216C-6R
LNFILE 5 Rev14.v1
VND TOYOCOM
LNFILE 5 Rev14.v1
QLF 0
CHS 1

CPN 004-020-101
LNFILE 5 Rev14.v1
VPL_MPN
VPL_VND VF
MPN VM6S-20.0000-16PF
LNFILE 6 Rev14.v1
VND VALPEY-FISHER
LNFILE 6 Rev14.v1
QLF 0
CHS 0

CPN_MPN_END
```

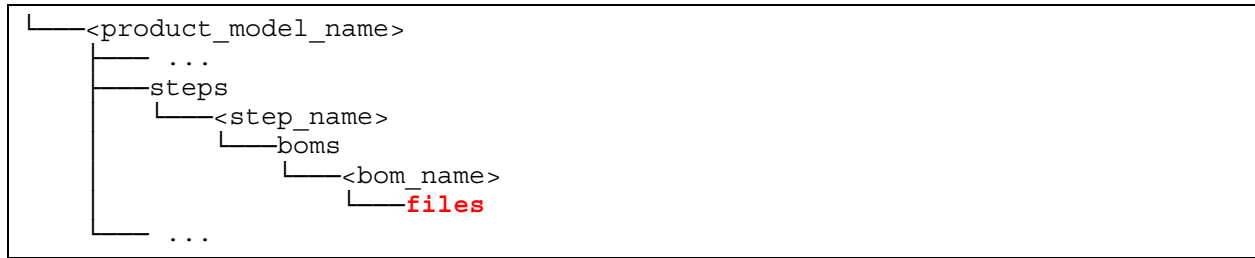
```
# Customer Parts and Description
CP
CPN 004-020-101
LNFILE 5 Rev14.v1
IPN
LNFILE 5 Rev14.v1
DSC 5 OHM
LNFILE 5 Rev14.v1
DSC UL Listed
LNFILE 5 Rev14.v1
DSC Weight 4
LNFILE 5 Rev14.v1
DSC Price 18
LNFILE 5 Rev14.v1
DSC
LNFILE 10 OHM Rev14.v1
PKG
LNFILE 5 Rev14.v1
QNT 1
ITEM 0

CPN 004-040-101
LNFILE 7 Rev14.v1
IPN
LNFILE 7 Rev14.v1
DSC 5 OHM
LNFILE 7 Rev14.v1
DSC Weight 3
LNFILE 7 Rev14.v1
DSC Price 24
LNFILE 7 Rev14.v1
DSC Height 0.05
LNFILE 7 Rev14.v1
DSC UL Listed
LNFILE 7 Rev14.v1
PKG
LNFILE 7 Rev14.v1
QNT 1
ITEM 0

CP_END
FILE_END
```

<bom_name>/files (Source Files)

The *files* directory contains the source files that generated the bom entity (BOM and AVL).



LNFILE lines in the *bom* file point to information stored in these files.

<step_name>/eda (Electronic Design Automation)

Several files are stored in the eda directory.

eda/data (EDA Data)	109
eda/shorts (Electrical Intention Short Net)	120
eda/hdi_netlist (HDI Netlist)	126

eda/data (EDA Data)

This file contains information that is read from the EDA system directly.

data	
Type	Line Record Text
Compression	Yes
Path	<product_model_name>/steps/<step_name>/eda/data
UNITS	The UNITS directive is required.

It covers the library of CAD and user-defined component packages, their outlines and properties, and net connectivity information.



This is an example of an eda *data* file:

```
#
HDR Mentor Boardstation database
UNITS=MM
LYR sst sst+1 sigt sig2 sig3 sig4 sig7 sig8 sig9 sigb smt smb drill spt ssb
spb ssb+1 pg6 pg5
#
PRP MILLING_ORIGIN 'MILLING 0 0.0 0' 0 0
PRP DRILL_ORIGIN '' 0 0
PRP FIXED_COMPONENT_LOCATION 'M3,m1' 1
....
#
#Net attribute names
#
#@0 .critical_net
#@1 .diff_pair
#@2 .net_type
#@3 .electrical_class
#@4 .dpair_gap
#@5 .eclass_rise_time
#@6 .eclass_max_stub_length
#
#
#Net attribute text strings
#
#&0 DEFAULT
#&1 clocks
#&2 EC_PUA
#&3 local
...

# NET 0
NET /D_CL_TX_CLK ;0,2=1,3=2,5=1.500000;ID=1030
SNT TOP T 16 0
FID C 2 33
FID C 10 33
FID C 13 30
...
# PKG 1
PKG *PDXC-L10/HX-L127W51T97 0.1 -0.25 -0.145 0.25 0.145
RC -0.25 -0.1 0.5 0.2
PIN 1 T -0.2 -0.1105 0 E S ID=1034
RC -0.2125 -0.145 0.025 0.069
PIN 3 T -0.1 -0.1105 0 E S ID=1038
RC -0.1125 -0.145 0.025 0.069
PIN 5 T 0 -0.1105 0 E S ID=1041
RC -0.0125 -0.145 0.025 0.069
PIN 7 T 0.1 -0.1105 0 E S ID=1044
RC 0.0875 -0.145 0.025 0.069
PIN 9 T 0.2 -0.1105 0 E S ID=1049
RC 0.1875 -0.145 0.025 0.069
PIN 2 T -0.2 0.1105 0 E S ID=1053
RC -0.2125 0.076 0.025 0.069
PIN 4 T -0.1 0.1105 0 E S ID=1054
RC -0.1125 0.076 0.025 0.069
PIN 6 T 0 0.1105 0 E S ID=1059
```

```

RC -0.0125 0.076 0.025 0.069
PIN 8 T 0.1 0.1105 0 E S ID=1073
RC 0.0875 0.076 0.025 0.069
PIN 10 T 0.2 0.1105 0 E S ID=1075
RC 0.1875 0.076 0.025 0.069
#
# PKG 2
PKG *MBCY-T2/XC-L80W80T115 0.1377953 -0.1574803 -0.1574803 0.1574803
0.1574803
CR 0 0 0.1574803
PIN P T 0.0688976 0 0 E T
CR 0.0688976 0 0.011811
PIN N T -0.0688976 0 0 E T
CR -0.0688976 0 0.011811

# FGR 1907
FGR TEXT
PRP string '030'
FID C 14 11018
FID C 14 11018

```

The file contains these types of records:

HDR — File Header Record	111
LYR — Layer Names Record	112
PRP — Property Record	112
@ and & — Net Attribute Lookup Table Records	112
NET — Electrical Net Record	114
SNT— Subnet Record	115
FID — Feature ID Record	116
PKG — Package Record	116
PIN — Pin Record	117
FGR — Feature Group Record	118
RC, CR, SQ, CT, OB, OS, OC, OE, CE — Outline Records	118

HDR — File Header Record

This record contains the name of the EDA system that was the source of the data.

HDR <source>

HDR Parameter	Explanation
source	A description of the EDA system from which the product model originated. For example: <ul style="list-style-type: none">• Mentor Boardstation neutral file• Mentor Boardstation database• Cadence Allegro extract file• Zuken Redac CADIF file• Mentor PADS

LYR — Layer Names Record

This record contains the names of the layers that are referenced in FID records.

See “[FID — Feature ID Record](#)” on page 116.

LYR <name1>.... <namen>

LYR Parameter	Explanation
name1, name2, ...	A legal layer name listed in the product model matrix.

PRP — Property Record

A property is a value associated with EDA entities—board, net, package, feature—that specifies some of their characteristics.

PRP <property_name> '<property_value>' n1 n2 ...

PRP Parameter	Explanation
property_name	Name of the property. The property name defines how to interpret the value.
property_value	String of the property (between single quotes).
n1,n2,...	Floating numbers to be kept in the property.

@ and & — Net Attribute Lookup Table Records

This section of the file contains a table of net attribute names and a table of all net attribute values that are strings.

- **Net attribute names** — Each record contains an at sign (@), an index, and an attribute name. For example, @0 .critical_net.

- **Net attribute text strings** — Each record contains an ampersand (&), an index, and a text string that can be used as the value of an attribute of type TEXT. For example, &3 local.

System attributes that can be placed in this table are listed with Entity = Net in the attribute description. See “[System Attributes](#)” on page 215

The lookup table must be placed before the first NET record in the file.

The NET records and PKG records in the file can assign net attributes by referencing the index of a net attribute and, for attributes of type TEXT, the index of the text string that is the value assigned to the attribute.

Note



For backward compatibility, net attributes can be preceded by the number sign (#).

This is an example of a net attribute lookup table, and a NET record that assigns attributes.

```
#Net attribute names
#
@0 .critical_net
@1 .diff_pair
@2 .net_type
@3 .electrical_class
@4 .dpair_gap
@5 .eclass_rise_time
@6 .eclass_max_stub_length
#
#Net attribute text strings
#
&0 DEFAULT
&1 clocks
&2 EC_PUA
&3 local
...

# NET 0
NET /D_CL_TX_CLK ;0,2=1,3=2,5=1.500000;ID=1030
```

The NET record in the example should be interpreted as assigning these attributes to a net named /D_CL_TX_CLK:

Assignment in the NET Record	Line in the Table of Attribute Names	Attribute Type	Line in the Table of Attribute Text Strings	Result
0	@0 .critical_net	BOOLEAN	-	.critical_net = TRUE
2=1	@2 .net_type	TEXT	&1 clocks	.net_type = clocks

Assignment in the NET Record	Line in the Table of Attribute Names	Attribute Type	Line in the Table of Attribute Text Strings	Result
3=2	@3 .electrical_class	TEXT	&2 EC_PUA	.electrical_class = EC_PUA
5=1.500000	@5 .eclass_rise_time	FLOAT	-	.eclass_rise_time = 1.5

NET — Electrical Net Record

This record contains a start record of an electrical net. Each net consists of one NET line and 0 or more SNT records.

NET <net_name>; <attributes>;ID=<id> where:

NET Parameter	Explanation
net_name	<p>The same net_name found in the netlist file with which the following records are associated.</p> <p>Net names are for reference only. Every NET record is considered a different electrical net, and should be electrically isolated from all other NET records. Ideally, the <net_name> should be unique across all NET records. <net_name> may contain only printable ASCII characters, excluding the blank space and the semi-colon (;) character.</p> <p>When a feature does not have a net defined it is assigned to NET \$NONE\$. All un-assigned outer layer pads are defined as NET \$NONE\$. With more than one \$NONE\$ net, each is disconnected from the other. Any two points of a \$NONE\$ net can be connected or disconnected, depending on the design.</p>
attributes	<p>A comma separated list of attribute assignments. The attribute is indicated by its index in the attribute name lookup table.</p> <ul style="list-style-type: none"> • BOOLEAN — n indicating that attribute n is set. • OPTION — n=m indicating that attribute n has value m. • INTEGER — n=i indicating that attribute n has value i. • FLOAT — n=f indicating that attribute n has value f. • TEXT — n=s indicating that attribute n has the value associated with index s in the attribute text string lookup table. <p>See “@ and & — Net Attribute Lookup Table Records” on page 112.</p>
ID=<id>	<p>Assigns a unique identifier to the net.</p> <p>See “Unique ID” on page 30.</p>

SNT— Subnet Record

This record defines a portion of a net. The portion can be one of these types of subnet:

- **Toeprint** — A connection of a component pin to the board.
- **Via** — A connectivity padstack between layers.
- **Trace** — A collection of lines or arcs leading from point to point.
- **Plane** — A surface used for connectivity purposes.

Each subnet record is followed by zero or more FID records mapped to the board features that are part of this subnet.

Structure for toeprint: SNT TOP <side> <comp_num> <toep_num>

SNT TOP Field	Explanation
TOP	Indicates that the subnet is a toeprint.
side	T — Top side of the product model. B — Bottom side of the product model.
comp_num	An index number (0...n-1) corresponding to the component record in the file <i>comp_+_top/components</i> or <i>comp_+_bot/components</i>
toep_num	An index number (0...n-1) corresponding to a toeprint record of the referenced component.

Structure for via: SNT VIA

SNT VIA Field	Explanation
VIA	Indicates that the subnet is a via.

Structure for trace: SNT TRC

SNT TRC Field	Explanation
TRC	Indicates that the subnet is a trace.

Structure for plane: SNT PLN <fill_type> <cutout_type> <fill_size>

SNT PLN Field	Explanation
PLN	Indicates that the subnet is a plane.
fill_type	S — Solid. O — Outline.

SNT PLN Field	Explanation
cutout_type	C — Circle. R — Rect. O — Octagon. E — Exact.
fill_size	Size in inches or mm of fill brush. (For solid fill, use the value 0.)

FID — Feature ID Record

This record contains a link to the feature file of layer number <lyr_num>. The record is used to connect subnets and feature groups to the board features that are part of them.

Structure: FID <type> <lyr_num> <f_num>

FID Parameter	Explanation
type	C — Copper. L — Laminate. H — Hole.
lyr_num	A layer number (0 ... n-1) corresponding to the names of layers in the LYR record
f_num	A feature number (0 ... n-1) corresponding to the feature record sequence in the features file.

This is an example of the f_num sequence in a feature file:

```
#
#Layer features
#
P 4.057087 4.5 6 P 0 0;1=6,3=0      #f_num = 0
P 4.057087 4.57874 6 P 0 0;1=6,3=0  #f_num = 1
P 4.057087 3.633858 6 P 0 0;1=6,3=0  #f_num = 2
P 4.057087 3.712598 6 P 0 0;1=6,3=0  #f_num = 3
```

PKG — Package Record

This record contains a definition of a package that is the generic shape of a component. Each component refers to a package.

Each PKG line must be followed immediately by one or more outline records, 0 or more property (PRP) records, and 0 or more pin records. See “[RC, CR, SQ, CT, OB, OS, OC, OE, CE — Outline Records](#)” on page 118.

The order in which the PKG records occur is used by the CMP record (pkg_ref) of the component file to determine the desired package. The order is referenced starting from 0 and up. See “[CMP — Component Record](#)” on page 157.

ODB++ requires closed geometries. That is, polygons must be closed and not intersect.

Structure: PKG <name> <pitch> <xmin> <ymin> <xmax> <ymax>; <attributes>; ID=<id>

PKG Parameter	Explanation
name	Name of the package as defined in the EDA system
pitch	Distance between center of closest pins, in inches or mm, based on the current unit of measure
xmin, ymin, xmax, ymax	Bounding box of package, relating to package datum
attributes	<p>A comma separated list of attribute assignments. The attribute is indicated by its index in the attribute name lookup table.</p> <ul style="list-style-type: none"> • BOOLEAN — n indicating that attribute n is set. • OPTION — n=m indicating that attribute n has value m. • INTEGER — n=i indicating that attribute n has value i. • FLOAT — n=f indicating that attribute n has value f. • TEXT — n=s indicating that attribute n has the value associated with index s in the attribute text string lookup table. <p>See “@ and & — Net Attribute Lookup Table Records” on page 112.</p>
ID=<id>	<p>Assigns a unique identifier the package.</p> <p>See “Unique ID” on page 30.</p>

PIN — Pin Record

This record contains a definition of a pin that belongs to a package.

Each Pin record is followed by at least one outline record. See “[RC, CR, SQ, CT, OB, OS, OC, OE, CE — Outline Records](#)” on page 118.

By default, pin #1 is determined by the first PIN record in the package. If the integer attribute .polarity_marker is assigned for the package, then that value overrides the default behavior by assigning pin #1 to the occurrence of the PIN record indicated by that integer.

Structure: PIN <name> <type> <xc> <yc> <fhs> <etype> <mtype> ID=<id>, where:

PIN Parameter	Explanation
name	Name of the pin as defined in the EDA system.

PIN Parameter	Explanation
type	T — Through-hole (top to bottom). B — Blind (top to inner or inner to bottom). S — Surface (top to top or bottom to bottom).
xc, yc	Center of pin, relating to package datum.
fhs	Finished hole size (currently not used—should be 0).
etype	Pin electrical type: E — Electrical. M — Non-electrical (mechanical). U — Undefined (default).
mtype	Pin mount type: S — SMT D — Recommended SMT pad (where the pin size is the recommended pad size and not the pin size). T — Through-hole. R — Through-hole where the pin size is the recommended hole size and not the pin size. P — Pressfit. N — Non-board, pins without contact area with the board. Used in components with lead forms of types: solder lug, high cable, or quick connect. H — Hole, for physical holes that appear without the physical pin U — Undefined (default).
ID=<id>	Assigns a unique identifier to the pin. See “ Unique ID ” on page 30.

FGR — Feature Group Record

This record contains the definition of a group of related features—for example, the strokes of a text record. Each FGR line is followed by zero or more FID records mapped to the board features that are part of this subnet.

Structure: FGR <type>, where <type> is the string TEXT—the only value allowed.

RC, CR, SQ, CT, OB, OS, OC, OE, CE — Outline Records

Outline records must follow a PKG or PIN record. They describe the shape of the package or pin.

A PKG record must have an outline record as the immediate next entry (an outline record can be more than one line). A PIN record does require an outline record but not immediately after.

A shape can consist of a simple shape (rectangle, circle, square) or a complex contour.

- **RC** — Rectangle record.

RC <lower_left_x> <lower_left_y> <width> <height>

- **CR** — Circle record.

CR <xc> <yc> <radius>

- **SQ** — Square record.

SQ <xc> <yc> <half side>

- **CT, OB ... CE** — Contour record.

The structure of a contour record is the same as a surface feature in the features file and is restricted by the same limitations. A contour consists of one or more polygons.

- Self-intersecting polygons (SIPs) are not allowed.
- The polygons must form a closed shape, as described:

A polygon starts with an **OB** command, contains **OS** (segment) or **OC** (arc) commands, and ends with an **OE** command.

```
OB <start_x> <start_y> I/H      (I=island, H=hole)
OS <end_x> <end_y>
OC <end_x> <end_y> <center_x> <center_y> <cw> (cw = y or n)
OE
```

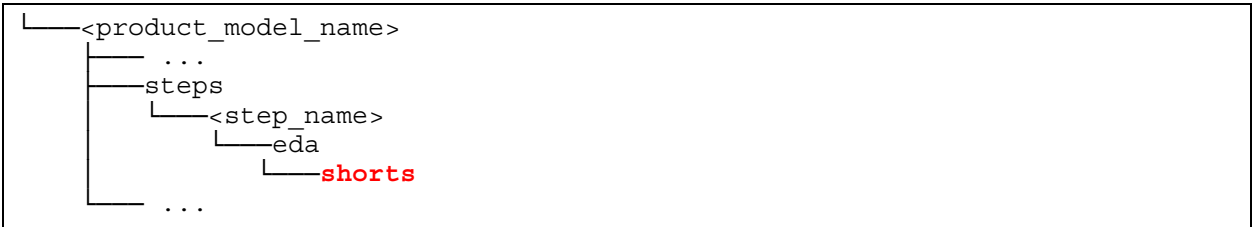
- Holes must be graphically contained inside island polygons.
- The arcs must be consistent (the start, end, and center point must construct a legal arc).

eda/shorts (Electrical Intention Short Net)

This file contains information that is read from the EDA system directly.

shorts (Electrical Intention Short Net)	
Type	Line Record Text
Compression	Yes
Path	<product_model_name>/steps/<step_name>/eda/shorts
UNITS	The UNITS directive is required.

The file contains a list of features that are known to create intentional net shorts within the product model.



If more than two nets are short together, each instance of the resulting net shorts must be defined separately. If the copper feature that caused the shorts has a net name, the number of shorts that must be defined is reduced.

Example of a shorts file:

```
#
UNITS=MM
LYR sst sigt sig2 sig3 sig4 sig7 sig8 sig9 sigb smt smb drill spt ssb spb
pg6 pg5
# SRT 1
SRT 1 7;ID=20
FID C 4 2
FID C 4 3
# SRT 2
SRT 2 7;ID=21
FID C 4 4
FID C 4 3
# SRT 3
SRT 3 7;ID=22
FID C 4 6
FID C 4 3
# SRT 4
SRT 4 7;ID=23
FID C 4 8
FID C 4 3
# SRT 5
SRT 5 7;ID=24
FID C 4 10
FID C 4 3
# SRT 6
SRT 6 7;ID=25
FID C 4 12
FID C 4 3
```

The file contains records of type LYR, FID, and SRT.

Record Type	Description
LYR — Layer Names in the Shorts File	This record contains the names of the layers that are referenced in FID records.
FID—Feature ID Record in the Shorts File	This record contains a link to the feature file of layer number <lyr_num>. The record is used to connect subnets and feature groups to the board features that are part of them.
SRT — Electrical Intention Short Net Record	This record is a start record for defining an intentional short.

LYR — Layer Names in the Shorts File

This record contains the names of the layers that are referenced in FID records.

This is the format of the LYR record:

LYR <name1>.... <namen>

LYR Parameter	Explanation
name1, name2, ...	A legal layer name listed in the product model matrix.

See “[FID—Feature ID Record in the Shorts File](#)” on page 122.

FID—Feature ID Record in the Shorts File

This record contains a link to the feature file of layer number <lyr_num>. The record is used to connect subnets and feature groups to the board features that are part of them.

This is the format of the FID record:

FID <type> <lyr_num> <f_num>

FID Parameter	Explanation
type	FID records in a <i>shorts</i> file can only be of type C or H. C — Copper. H — Hole.
lyr_num	A layer number (0 ... n-1) corresponding to the names of layers in the LYR record
f_num	A feature number (0 ... n-1) corresponding to the feature record sequence in the features file.

This is an example of the f_num sequence in a feature file:

```
#
#Layer features
#
P 4.057087 4.5 6 P 0 0;1=6,3=0      #f_num = 0
P 4.057087 4.57874 6 P 0 0;1=6,3=0  #f_num = 1
P 4.057087 3.633858 6 P 0 0;1=6,3=0 #f_num = 2
P 4.057087 3.712598 6 P 0 0;1=6,3=0 #f_num = 3
```

SRT — Electrical Intention Short Net Record

This record is a start record for defining an intentional short.

Each short definition contains at least two FID records, or one from each net name. The need for multiple FID records that go through layers would result from a via or through hole location participating in a short.

If the same nets are shorted together in multiple locations for a single product model, then the multiple short locations should be recorded separately and each would contain its own FID related records. This also means that there might be more than one SRT record containing the same NET net_name IDs.

If more than two nets are short together, each instance of the resulting net shorts must be defined separately. For example, if there are three nets, net1, net2 and net3 that are shorted together, then the short of net1 to net2, net2 to net3 and net3 to net1 will need to be listed in the file.

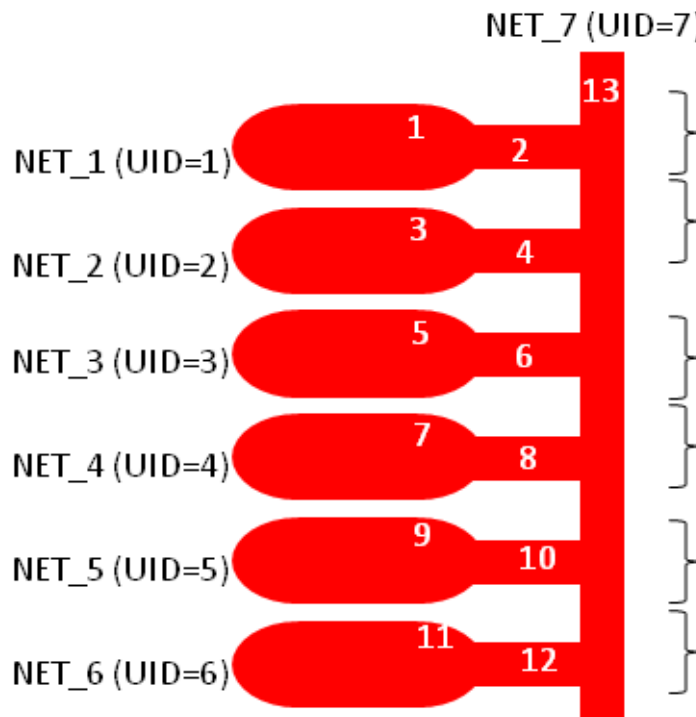
This is the format of the SRT record:

SRT <net_name1_uid> <net_name2_uid> ID=<id>

SRT Parameter	Explanation
net_name1_uid	The ID from the NET record from within the <i>eda/data</i> file referencing the first net shorted together.
net_name2_uid	The ID from the NET record from within the <i>eda/data</i> file referencing the second net shorted together.
ID=<id>	A fixed string to indicate the following value is a unique ID, and its numerical value within the legal range of 0 - 4294967295 (optional).

Example of Multiple Nets Shorted with a Copper Feature With a Net Name

This is an example of multiple nets shorted together, where the copper feature is provided a net name.

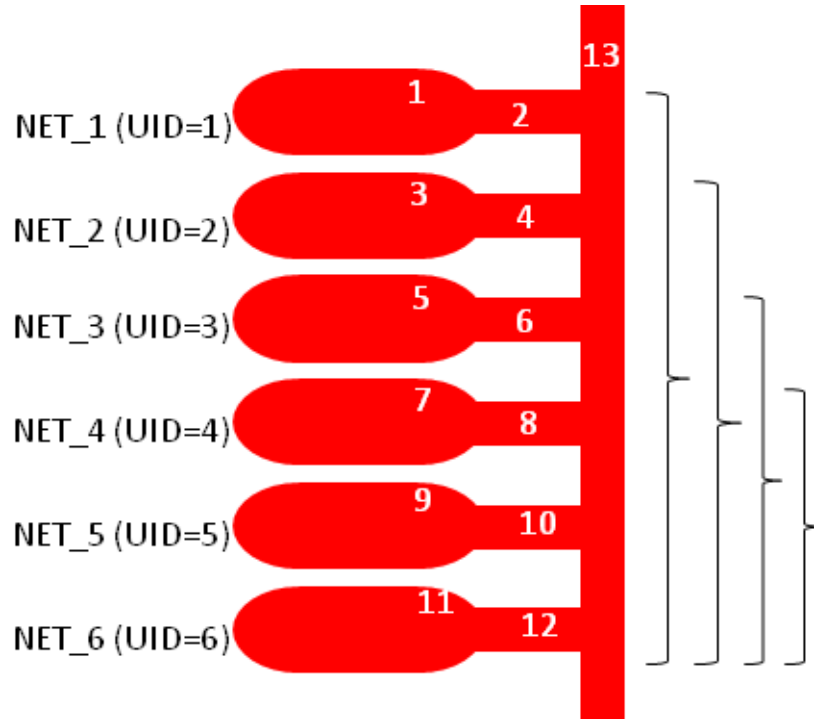


In this example, copper feature 13, which causes the short, has a net name with UID = 7. Six SRT sections are required. Each one describes a short between net 7 and one of the other six nets. Each SRT section has two FID lines. Each one identifies a feature involved in the short.

```
# SRT 1
SRT 1 7;ID=20
FID C 4 2
FID C 4 13
# SRT 2
SRT 2 7;ID=21
FID C 4 4
FID C 4 13
# SRT 3
SRT 3 7;ID=22
FID C 4 6
FID C 4 13
# SRT 4
SRT 4 7;ID=23
FID C 4 8
FID C 4 13
# SRT 5
SRT 5 7;ID=24
FID C 4 10
FID C 4 13
# SRT 6
SRT 6 7;ID=25
FID C 4 12
FID C 4 13
```

Example of Multiple Nets Shorted With a Copper Feature Without a Net Name

This is an example of multiple nets shorted together, where the copper feature is not provided a net name:



In this example, copper feature 13, which causes the short, does not have a net name. Fifteen SRT sections are required—one for each possible pair of the six nets that are shorted together by copper feature 13:

1-2, 1-3, 1-4, 1-5, 1-6

2-3, 2-4, 2-5, 2-6

3-4, 3-5, 3-6

4-5, 4-6

5-6

Each SRT section has three FID lines to define the three features involved in the short.

```
# SRT 1
SRT 1 2;ID=20
FID C 4 2
FID C 4 13
FID C 4 4
# SRT 2
SRT 1 3;ID=21
FID C 4 2
FID C 4 13
FID C 4 6
# SRT 3
SRT 1 4;ID=22
FID C 4 2
FID C 4 13
FID C 4 8
# SRT 4
SRT 1 5;ID=23
FID C 4 2
FID C 4 13
FID C 4 10
# SRT 5
SRT 1 6;ID=24
FID C 4 2
FID C 4 13
FID C 4 12
# SRT 6
SRT 2 3;ID=25
FID C 4 4
FID C 4 13
FID C 4 6
# SRT 7
SRT 2 4;ID=26
FID C 4 4
FID C 4 13
FID C 4 8
# SRT 8
SRT 2 5;ID=27
FID C 4 4
FID C 4 13
FID C 4 10
# SRT 9
SRT 2 6;ID=28
FID C 4 4
FID C 4 13
FID C 4 12
...
```

eda/hdi_netlist (HDI Netlist)

A netlist defining wire bond connection is defined in this file.

hdi_netlist	
Type	Structured Text

hdi_netlist	
Compression	No
Path	<i><product_model_name>/steps/<step_name>/eda/hdi_netlist</i>
UNITS	The UNITS directive is required.

This netlist defines connections between pins of source and destination components for nets including wire bonds.



Examples are given for each array structure.

The hdi_netlist file contains these array structures: HDI_NETLIST_DATABASE, HDI_PACKAGE, HDI_NET_POINT, HDI_NET_BRIDGE

HDI_NETLIST_DATABASE Array Structure

The file contains a single HDI_NETLIST_DATABASE record containing common information.

Parameter	Explanation
units	Units of coordinates in the file. (INCH / MM)
source	Application used to create ODB++, or input source if created by Valor NPI.
version	Netlist version.

Example of the HDI_NETLIST_DATABASE section:

```

HDI_NETLIST_DATABASE {
    units=MM
    source=ExpeditionPCB
    version=2.0
}
  
```

HDI_PACKAGE array structure

The file contains a HDI_PACKAGE records for each component involved in the netlist. These components are specified in the die parameter or the dest_comp parameter of the HDI_NET_POINT records.

Parameter	Explanation
name	Name of a component used in HDI_NET_POINT records.
ref_des	Reference designator of the corresponding component in the design (usually the same as the value in name).
type	DIE or SRC for a source component; BGA or DST for a destination component.

Example of the HDI_PACKAGE section:

```
HDI_PACKAGE {
    name=U4
    ref_des=U4
    type=DIE
}
```

HDI_NET_POINT Array Structure

The file contains multiple HDI_NET_POINT records for all pins of source and destination components connected by wire bonds. The records contains the same fields for both source and destinations but some fields are empty depending on the net point and connection type..

Parameter	Explanation	Source and Destination
net	Name of die bump net (should be the same as the value of .net attribute of corresponding pad in wire bond layer).	pin to pin pin to net pin to gate
x, y	Die bump coordinates (the same—within a certain tolerance—as the coordinates of the corresponding pad in the wire bond layer).	pin to pin pin to net pin to gate
sym	Similar to the symbol name of corresponding pad in wire bond layer.	pin to pin pin to net pin to gate
die	Name of the source component. An HDI_PACKAGE record must exist for the component.	pin to pin pin to net pin to gate
bump	Name of the source component pin.	pin to pin pin to net pin to gate

Parameter	Explanation	Source and Destination
gate	Gate name. This is used as a key to find the corresponding destination gate record. See the examples. ODB++ does not contain a corresponding entity, feature, or attribute.	pin to gate
dest_net	Name of the destination net.	pin to net destination net
dest_comp	Name of the destination component. An HDI_PACKAGE record must exist for the component.	pin to pin pin to net destination net destination gate
dest_pin	Name of destination component pin.	pin to pin destination net destination gate
dest_gate	Name of the destination gate. The gate parameter in a pin to gate record points to a gate specified in the dest_gate parameter of a destination gate record. See the examples.	destination gate

Example of the HDI_NET_POINT section for a source pin connected to a destination pin

```
HDI_NET_POINT {
  net=X_X_ATB1TL
  x=-6.430395
  y=4.160125
  sym=rect60x49
  die=U1
  bump=35
  gate=
  dest_net=
  dest_comp=B1
  dest_pin=B4
  dest_gate=
}
```

Example of the HDI_NET_POINT section for a source pin connected to a destination net

A record specifying a destination net instead of a destination pin is used for a net containing multiple pins of the same destination component (typically power / ground nets).

Each pin of the destination component connected to such a net should be represented by separate HDI_NET_POINT record for a destination net.

```
HDI_NET_POINT {  
    net=X_X_ATB1TL  
    x=-6.430395  
    y=4.160125  
    sym=rect60x49  
    die=U1  
    bump=35  
    gate=  
    dest_net=X_X_ATB1TL  
    dest_comp=  
    dest_pin=  
    dest_gate=  
}
```

Example of the HDI_NET_POINT section for a destination net

Multiple records with the same dest_net are allowed. Typically, the destination net and source net are the same, but different nets are also supported.

```
HDI_NET_POINT {  
    net=  
    x=  
    y=  
    sym=  
    die=  
    bump=  
    gate=  
    dest_net=X_X_ATB1TL  
    dest_comp=B1  
    dest_pin=B4  
    dest_gate=  
}
```

Example of the HDI_NET_POINT section for a source pin connected to a destination gate

```
HDI_NET_POINT {  
    net=X_X_ATB1TL  
    x=-6.430395  
    y=4.160125  
    sym=rect60x49  
    die=U1  
    bump=35  
    gate=GATE23  
    dest_net=  
    dest_comp=  
    dest_pin=  
    dest_gate=  
}
```

Example of the HDI_NET_POINT section for a destination gate

Multiple records with the same dest_gate are allowed. Source and destination net should be the same in the case of a connection to a gate.

```
HDI_NET_POINT {
    net=
    x=
    y=
    sym=
    die=
    bump=
    gate=
    dest_net=
    dest_comp=B1
    dest_pin=B4
    dest_gate=GATE23
}
```

HDI_NET_BRIDGE array structure

The netlist file can contain an optional section for a direct wire bond connection in the same copper layer. No component pins are involved in such a connection.

Parameter	Explanation
net	Name of the net with a direct wire bond connection.
x1, y1	Coordinates of one of the connected points. The copper layer should contain pads with similar coordinates or lines / arcs with similar endpoints.
x2, y2	Coordinates of one of the connected points. The copper layer should contain pads with similar coordinates or lines / arcs with similar endpoints.

Example of an HDI_NET_BRIDGE section

```
HDI_NET_BRIDGE {
    net=VCCEL_L
    l=0.37
    y1=0.54
    x2=0.385
    y2=0.544
}
```

<step_name>/impedance.xml (Impedance)

The optional impedance file contains data relevant to the calculation of copper impedance for the step.

StackupFile (Stackup)	
Type	XML
Compression	None
Path	<product_model_name>/steps/<step_name>impedance.xml

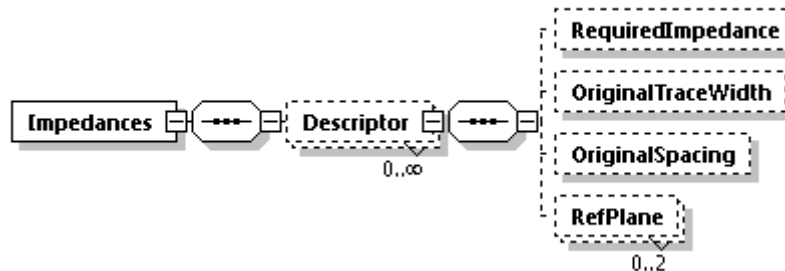


Structure of the Impedance File 133

Structure of the Impedance File

The Impedances element contains instances of the Descriptor section.

Figure 4-1. Impedance File



Descriptor

A list of impedance requirements for the trace features that bear the id attribute and reside in the layer having a specific name.

Child elements:

- **RequiredImpedance** — The required impedance values (0-1)
- **OriginalTraceWidth** — The original trace width for the required impedance (0-1)
- **OriginalSpacing** — The original spacing between copper for the required impedance (0-1)
- **RefPlane** — The list of layers that represent the reference planes in impedance calculation (0-2)

Example:

```

<Impedances Version="8.1" MaxImpIdValUsed="3">
  <Descriptor Id="1" TraceLayerName="t10">
    <RequiredImpedance ValOhms="50" PlusVal="5" MinusVal="5"
    ValPercent="true"/>
    <OriginalTraceWidth Val="0.5" Units="MIL"/>
    <OriginalSpacing Val="1" Units="MICRON"/>
    <RefPlane Val="g09"/>
  </Descriptor>
</Impedances>

```

The schema is described in “[Impedances](#)” on page 512.

<step_name>/layers

Layers express physical board layers, and also mask layers, NC drill and rout layers, and miscellaneous drawings.

See “[Layer Entities](#)” on page 151 for a discussion of the files relating to the layers.

<step_name>/netlists

These files are related to the netlists entity.

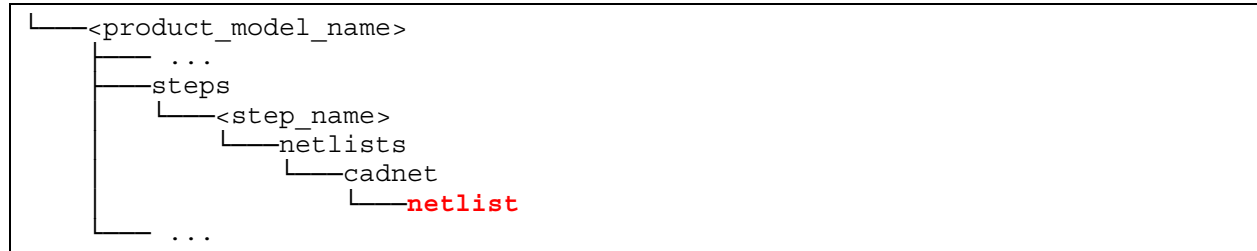
cadnet/netlist (cadnet)	135
refnet/netlist (Reference)	141

cadnet/netlist (cadnet)

This file represents a netlist as it was read from an external CAD system. A netlist is a collection of nets, each one referencing a group of points.

cadnet/netlist (cadnet)	
Type	Line Record Text
Compression	None
Path	<product_model_name>/steps/<step_name>/netlists/cadnet/netlist
UNITS	The UNITS directive is required.

When a feature does not have a net defined, it is assigned to NET \$NONE\$. All non-assigned features are defined as NET \$NONE\$. See “[NET — Electrical Net Record](#)” on page 114.



The files consists of a header line, a list of nets, and a list of net points.

Header Line

The first line of the file is the header line. It has this syntax:

H optimize <y|n> [staggered <y|n>]

Field	Explanation
optimize	y — Netlist was optimized for bare board testing. n — Netlist was not optimized. For CAD netlists, the net will always be non-optimized.

Field	Explanation
staggered (optional)	y — Netlist points have been staggered for testing. n — Netlist points have not been staggered for testing.

List of Nets

The net section of the file contains lines with this syntax:

\$<serial_num> <net_name>

Field	Explanation
serial_num	The net serial number, starting with 0.
net_name	A unique name representing the name of a net. A typical practice is to use the original net name used in the design system.

Net names are for reference only. Every <serial_num> net is considered a different electrical net, and should be electrically isolated from all different <serial_num> nets. Ideally, every <serial_num> net should have a different <net_name>. There is no limit on the length of a <net_name>, but <net_name> may contain only printable ASCII characters, excluding the blank space and the semi-colon (;) character.

List of Net Points

The net point section of the file lists the net points. It contains lines of this syntax:

```
<net_num> <radius> <x> <y> <side> [<w> <h>] <epoint> <exp> [<"c">]
["staggered" <sx> <sy> <sr>] [<"v">] [<"f">] [<"t">] [<"m">] [<"x">]
[<"e">] ["by="<by>] ["arsize_top="<arsize_top>]
["arsize_bot="<arsize_bot>] ["is_shrink="<is_shrink>] ["ld="<ld>]
```

In the syntax line, these conventions are used:

- < > — Angled brackets represent a single field or value.
- [] — Square brackets represent optional fields.
- " " — Quotation marks represent literal strings.

Positional parameters must be placed in the correct order on the line. Keyword parameters can be placed at any position on the line, after the positional parameters.

Fields are space delimited. There should be no spaces before or after an equals sign (=).

Field	Explanation
net_num	<p>Index of the net as defined in the list of nets.</p> <p>For example, if the list of nets includes this line: \$0 MYNET</p> <p>Then these net point lines refer to the net MYNET because the first value in these lines is a zero:</p> <pre>0 0.002 4.96 -2.64 T e e staggered 0 0 0 0 0.002 4.94 -2.4775 T e e staggered 0 0 0 0 0.002 4.945 -2.575 B e e staggered 0 0 0</pre> <p>A net index value of -1 can be used to represent tooling holes. When a feature is found with no reference to a net index, the net name \$NONE\$ should be assigned to the feature.</p>
radius	<p>Drill radius (inches or mm). For SMD pads:</p> <ul style="list-style-type: none"> • In cadnet — 0.002 (independent of units) • In reference net — 0 inch.
x, y	Point coordinates (inches or mm).

Field	Explanation
side	<p>The side from which the net point is accessible.</p> <ul style="list-style-type: none"> • T (top) — Indicates net points accessible from the TOP side of the ODB++ product model. This includes net points placed on inner layers, but accessible from the TOP side through the use of a layer profile hole (cavity). The layer on which a net point resides is defined by the ld parameter. If the ld field is missing, the TOP layer UID is assumed. • D (down) — Indicates net points accessible from the BOTTOM side of the ODB++ product model. This includes net points placed on inner layers, but accessible from the BOTTOM side through the use of a profile hole (cavity). The layer on which a net point resides is defined by the ld parameter. If the ld field is missing, the BOTTOM layer UID is assumed. • B (both) — Indicates net points accessible from TOP and BOTTOM sides of the ODB++ product model. This includes net points placed on inner layers, but accessible from the TOP side and the BOTTOM side through the use of a profile hole (cavity). In this case the net points are accessible from both sides of the product model by means of plated through holes, and non_plated and via holes are excluded. The layers on which a net point resides is defined by the ld value of the drill/rout layer defining the hole location. The matrix information for the associated drill/rout layer provides the layer accessibility from the TOP and BOTTOM side. If the ld field is missing or does not represent a drill/rout layer, the TOP and BOTTOM layer UIDs are used to define the layer on which to place the net point. • I (inner) — Indicates net points that are not accessible from the TOP or BOTTOM side of the ODB++ product model. These are net points resulting from completely buried inner layer surface connections, not exposed by a profile hole (cavity). In this case the net points exclude all internal plated, non_plated and via holes. The layer on which the net point resides is based on the ld parameter. <p>Previous format definitions included following the letter I by an integer representing the layer position within the matrix. This use is now obsolete.</p>
w, h	Width and height of non-drilled pads (only when radius = 0).
epoint	<p>e — Net end point.</p> <p>m — Net mid point.</p>
exp	<p>e — Solder mask exposed point.</p> <p>c — Solder mask covered point.</p> <p>p — Solder mask covered point on top side of product model.</p> <p>s — Solder mask covered point on bottom side of product model.</p>

Field	Explanation
c	Comment point flag used to mark net points that are irrelevant to the product model. For example, these points can be ignored during the net comparison process.
sx, sy	Coordinates of staggered point (where probe location is other than net point location).
sr	Represents the radius of a probe to be used at this location.
v	Via point.
f	Fiducial point.
t	Test point.
m	Present when a netlist point is designated as a test point by assigning it the .critical_tp attribute. Normally this is applied to mid-points that need to be tested. If both .non_tp and .critical_tp are assigned to the same point, .critical_tp takes precedence and the mid point is tested. In case of a drilled pad, the attribute must be added to the drill hole.
x	<p>This indicates that there are extension records in the netlist file. Extension records contain the e keyword and have the same location. A net point description for an extended point does not have to be grouped together in the netlist file.</p> <pre>0 0.00675 0.8 3.3 B m e v x by=b 0 0 2.5 3.214393 T 0.04242 0.04242 e s staggered 0 0.01325 0 e by=c ld=111</pre>
e	<p>This indicates that this is an extension record for a line containing the x keyword. A net point description for an extended point does not have to be grouped together in the netlist file.</p> <pre>0 0.00675 0.8 3.3 B m e v x by=b 0 0 2.5 3.214393 T 0.04242 0.04242 e s staggered 0 0.01325 0 e by=c ld=111</pre>
by	<p>Defines how a test is executed: (c s b a n)</p> <p>c — Test from component side.</p> <p>s — Test from solder side.</p> <p>b — Test from both sides.</p> <p>a — Test from any one side.</p> <p>n — Side not defined (default).</p> <p>If <by> value not defined, n is assumed.</p>

Field	Explanation
arsize_top	<p>The annular ring size for top represents the minimum width of exposed copper (from solder mask) around a drill hole on the top outer layer.</p> <p>If the hole does not go through the top layer, arsize_top should not be defined or should be set to 0. Example:</p> <pre>4 0.023622 0.726 0.3351969 B m e arsize_top=0.016378 arsize_bot=0.0161873 4 0.015748 0.7460787 0.5300787 B e e by=a arsize_top=0.011752 arsize_bot=0.0116406 4 0.011811 0.0358425 0.1450394 B m c arsize_top=0 arsize_bot=0</pre>
arsize_bot	<p>The annular ring size for bottom represents the minimum width of exposed copper (from solder mask) around a drill hole on the bottom outer layer.</p> <p>If the hole does not go through the bottom layer, arsize_bot should not be defined or should be set to 0. Example:</p> <pre>4 0.023622 0.726 0.3351969 B m e arsize_top=0.016378 arsize_bot=0.0161873 4 0.015748 0.7460787 0.5300787 B e e by=a arsize_top=0.011752 arsize_bot=0.0116406 4 0.011811 0.0358425 0.1450394 B m c arsize_top=0 arsize_bot=0</pre>
is_shrink	<p>Indicates that the radius field, which should contain the diameter of the drill, was shrunk to fit the solder mask opening or pad size. (y[es]/[no])</p> <p>y — Point size was shrunk to fit solder mask opening.</p> <p>n — Point size is limited only by pad size.</p>
ld	<p>Defines to which layer a net point belongs. The layer is defined by its unique ID. See “Unique ID” on page 30. Optional for top and bottom side, and obligatory for inner points.</p>

Example of a cadnet netlist file

```

UNITS=MM
H optimize n staggered n
$0 &1N1096
$1 &1N1526
$2 &1N289
$3 &1N312
$4 &1N338
$5 &1N340
$6 $NONE$
...
#
#Netlist points
#
0 0.002 4.96 -2.64 T e e staggered 0 0 0
0 0.002 4.94 -2.4775 T e e staggered 0 0 0
0 0.002 4.945 -2.575 B e e staggered 0 0 0
1 0.002 4.31 -4.045 T e e staggered 0 0 0
1 0.002 4.27 -3.893 T e e staggered 0 0 0

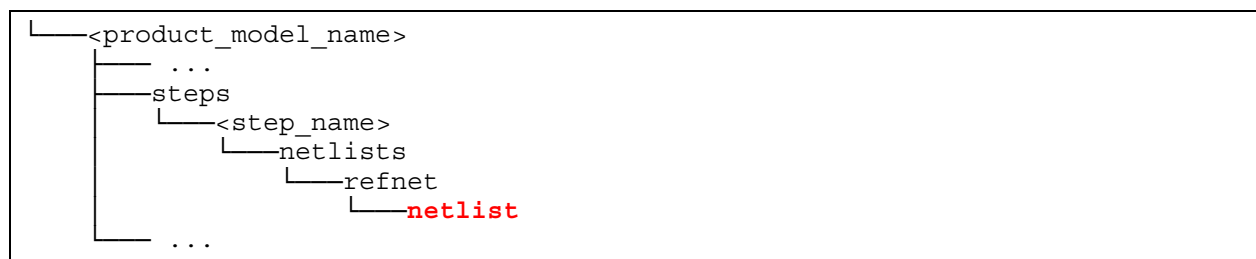
```

refnet/netlist (Reference)

This file describes the reference netlist for the step. A reference netlist describes net connectivity as it should be, derived from actual connectivity of the board. This netlist file should be generated and used as the source netlist of choice.

refnet/netlist (Reference)	
Type	Line Record Text
Compression	None
Path	<product_model_name>/steps/<step_name>/netlists/refnet/netlist
UNITS	The UNITS directive is required.

The format of the file is identical to that of “[cadnet/netlist \(cadnet\)](#)” on page 135.



<step_name>/profile (Outline Shape of Step)

The step profile defines the outline shape of the step. It is required by many operations.

profile (Outline Shape of Step)	
Type	Structured Text
Compression	None
Path	<product_model_name>/steps/<step_name>/profile
UNITS	The UNITS directive is required.

A profile is created using a single surface feature representing the outline of the step with optional internal holes (cutouts). There can be only one island, but any number of holes inside the island. Holes cannot touch the island boundary or one another.



The *profile* file is a *features* file defining a single surface feature. Surface features are defined as described in “<layer_name>/features (Graphic Features)” on page 170.

Example of a Step Profile File

```

UNITS=MM
ID=58
#
#Num features
#
F 1
#
#Layer features
#
S P 0
OB -49.9341975 -64.2563075 I
OS -49.9341975 -0.5988325
OS -0.518735 -0.5988325
OS -0.518735 -64.2563075
OS -49.9341975 -64.2563075
OE
OB -44.3237075 -43.97223 H
OS -15.839685 -43.97223
OS -15.839685 -13.7619025
OS -44.3237075 -13.7619025
OS -44.3237075 -43.97223
OE
SE

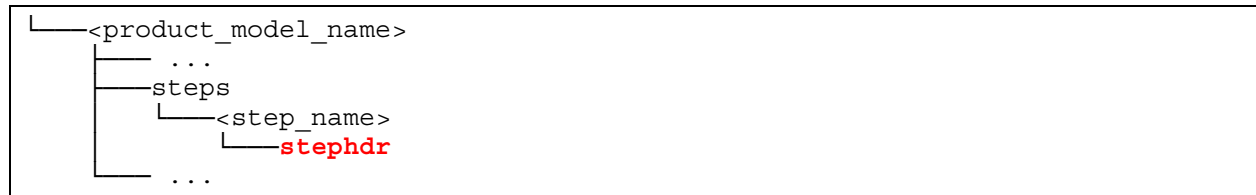
```

<step_name>/stephdr (Step Header)

This file contains data that is common to the whole step. This includes the step and repeat array for nested steps.

stephdr (Step Header)	
Type	Structured Text
Compression	None
Path	<product_model_name>/steps/<step_name>/stephdr
UNITS	The UNITS directive is required.

The graphic order of precedence for features is as defined in “[Geometric Entities](#)” on page 39. When using step repetitive format content within *stephdr* (DX, DY, NX, NY), the referenced step begins at location (X, Y). Subsequent reference steps are first shifted the distance of DX—NX number of times—to complete the first row of reference steps. The format then returns to the previous (X, Y) location, shifts the distance of DY (new Y location), and begins the NX repeat again, completing the next row. This is completed NY number of times. The sequence in which the reference steps are added determines order of precedence for each repeated step, as defined also in “[Geometric Entities](#)” on page 39.



The file consists of general fields, and an array of STEP-REPEAT records that exists only if there are nested steps.

These are the general fields:

Field	Explanation
X_DATUM	X datum point (used for step and repeat).
Y_DATUM	Y datum point (used for step and repeat).
ID	A unique ID (optional). See “ Unique ID ” on page 30.
X_ORIGIN	X origin point. Defines the location of the x-zero point (0, 0) in relation to the feature positions.
Y_ORIGIN	Y origin point. Defines the location of the y-zero point (0, 0) in relation to the feature positions.

Field	Explanation
TOP_ACTIVE BOTTOM_ACTIVE RIGHT_ACTIVE LEFT_ACTIVE	Active area is the area allowed for step and repeat of substeps. It is used to define the border width on the panel edges that should be kept free for placement of coupons and targets. These fields are used only when the step is a panel or array that is meant to contain other steps. (optional)
AFFECTING_BOM	The product model can contain several relevant BOMs. Only one BOM describes the current state of the product model. This field contains the integer 0 to represent that BOM.
AFFECTING_BOM_CHANGED	When a product model is modified to use a different BOM, but the necessary update processes have not been run (for example, package geometries have not been updated to the new BOM) then this field contains the integer 1 .
ONLINE_<online_type>	Obsolete parameters maintained for backward compatibility that may be any number of the DRC_* or NET_* parameters (Obsolete)

These are the fields in the STEP-REPEAT array:

Field	Explanation
NAME	Name of the step to be included in the current step. It must be a valid step in the same product model, without nesting or circular referencing.
X	Start X coordinate for placement of the datum point of the nested step. See the X_DATUM field among the general fields.
Y	Start Y coordinate for placement of the datum point of the nested step. See the Y_DATUM field among the general fields.
DX	Horizontal distance between datum points (when ANGLE = 0).
DY	Vertical distance between datum points (when ANGLE = 0).
NX	Number of repetitions horizontally.
NY	Number of repetitions vertically.
ANGLE	Rotation angle of the steps (see “ Angles ” on page 34).

Field	Explanation
FLIP	When set to YES , all layers in the step instance are mirrored and the layer order is reversed. This can be done only with steps that have a symmetrical buildup (both layer polarities and layer types should be symmetrical).
MIRROR	YES for mirror (around x-axis), NO for no mirror.

Example of the stephdr file

The file consists of general fields, and an array of STEP-REPEAT records that exists only if there are nested steps.

```

UNITS=INCH
X_DATUM=0
Y_DATUM=0
ID=123456

STEP-REPEAT {
NAME=1UP
X=1.5
Y=1.6
DX=1.2
DY=1.2
NX=6
NY=6
ANGLE=0
FLIP=NO
MIRROR=NO
}
TOP_ACTIVE=1
BOTTOM_ACTIVE=1
RIGHT_ACTIVE=1
LEFT_ACTIVE=1
AFFECTING_BOM=
AFFECTING_BOM_CHANGED=0

```

<step_name>/zones (Matrix Broken Into Sections)

The *zones* file is optional. When the file exists, the content provides a cross-sectional view of areas within the profile of a step that are the same.

zones (Matrix Broken into Sections)	
Type	Structured Text
Compression	None
Path	<product_model_name>/steps/<step_name>/zones

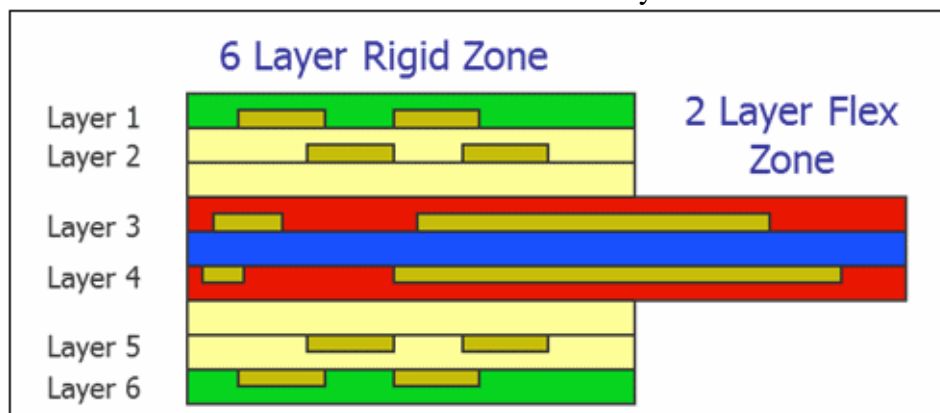
UNITS	The UNITS directive is required.
-------	----------------------------------

The file is comprised of multiple regions, or zones, that are defined by surfaces where the board layer materials, including the base layer types of SIGNAL, POWER_GROUND, MIXED, DIELECTRIC, SOLDER_MASK, SOLDER_PASTE, MASK and CONDUCTIVE_PASTE and the associated subtype for each, through the matrix, are identical. An air gap between layers does not require the creation of an additional zone.

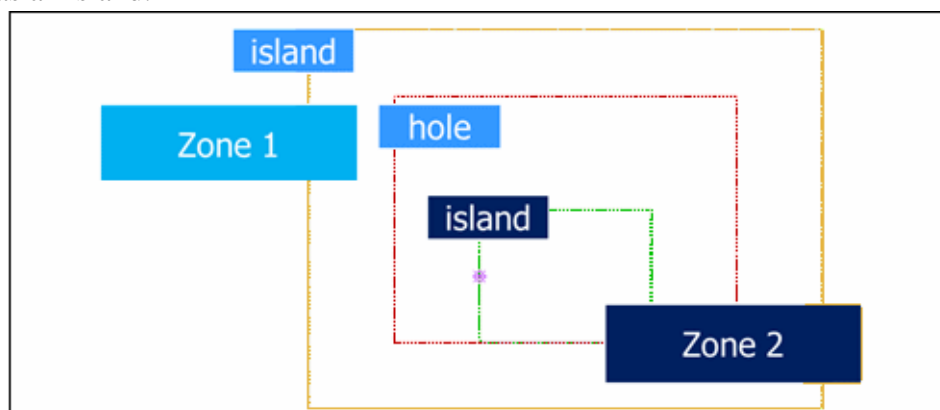


For each zone, the *zones* file contains information about the zone, a list of layers in the zone, properties of each of the layers (optional), and a surface feature that describes the outline, islands, and holes of the zone.

This graphic illustrates a cross section of a board and the layers for which zones are defined.



This graphic illustrates the surfaces defined for the zones. Zone 1 has an island and a hole. Zone 2 has an island.



A *zones* file has several types of records: ZONE (start record), LYR (layer record), PRP (properties record), S (surface defining zone area)

ZONE - Start Record

Start zone record: ZONE <name>;zone_UID

Defines the start of a zone by providing a name by which the zone will be referenced.

ZONE Record Parameter	Explanation
name	The name of each zone must be unique and follow ODB++ standard entity guidelines.
zone_UID	A unique ID for this zone.

LYR - Layer Record

Layer record: LYR <layer_UIDs>

Lists the layers that belong to the zone.

LYR Record Parameter	Explanation
layer_UIDs	<p>The list of layer_UIDs to which the ZONE applies.</p> <p>This includes dielectric UIDs.</p> <p>These layer UIDs must be defined in the matrix. See “matrix (Product Model Matrix)” on page 51.</p>

PRP - Properties Records

Properties Record: PRP <name> <value> <units> <layer_UIDs>

Optional. Defines properties of specific layers, such as the enlargement factor or the copper area.

PRP Record Parameter	Explanation
name	<p>One of these names:</p> <ul style="list-style-type: none"> • enlarge_zone — The amount by which the zone will be enlarged. This would apply in situations where the coverlay intrudes into the rigid region of the board (known as a bikini coverlay). • copper_area — The copper area for a layer within the zone. This would typically be used with a single layer_UID.

PRP Record Parameter	Explanation
value	The values appropriate to the specified name. <ul style="list-style-type: none"> • name = enlarge_zone — The enlargement amount. • name = copper_area — The copper area.
units	Units follow unit of measurements ODB++ format guidelines.
layer_UIDs	The list of layer_UIDs to which the property is assigned. The layer_UIDs must be among those listed in the LYR record for this zone.

S - Surface Defining the Zone Area

The records following the LYR record, and possibly the optional PRP records, define a zone as a single surface feature representing the outline of the zone with its optional internal holes (cutouts). Each zone can be constructed using multiple islands with any number of holes inside each island.

The zones follow the rules that apply to the ODB++ contour definition. These specific rules apply:

- An island must completely surround its holes.
- Holes must not touch one another or intersect within the island.
- No islands defined by two different zones enforced on single layer can intersect, but an island from one zone can be tangent to an island of another zone on a single layer.
- No features other than a surface are legal in the *zones* file.
- A zone may not exist outside of the area defined by the board profile.
- In order for a zone to be defined within a zone, a hole must first be created in the encompassing island.

A surface is defined in a *zones* file with the same syntax used in a *features* file. See “[S — Surface Records](#)” on page 185.

Example of a zones file

```
UNITS=INCH
ID=2411100

#
# Zone 1
#
ZONE area1;UID=2411111
LYR 23 45 78 97
PRP copper_area 2.23 INCH 23
PRP copper_area 5.53 INCH 45
PRP copper_area 6.23 INCH 78
PRP copper_area 2.73 INCH 97
S P 0;;ID=2452187
OB -2 -2 I
OS -2 4
OS 4 4
OS 4 -2
OS -2 -2
OE
OB -1 -1 H
OS 3 -1
OS 3 3
OS -1 3
OS -1 -1
OE
SE
#
# Zone 2
#
ZONE area2;UID=2411112
LYR 45 75
PRP copper_area 1.23 INCH 45
PRP copper_area 3.53 INCH 75
S P 0;;ID=2503253
OB 2 1 I
OS 2 -1
OS 0 -1
OS 0 1
OS 2 1
OE
SE
```


Chapter 5

Layer Entities

Product model layers can contain graphics, properties and annotation. Layers represent physical board layers, NC drills and rout layers, miscellaneous drawings, and dielectric separators. The order in which layers are arranged is based on the content in the matrix. Layers of type DIELECTRIC can only contain information representing material attributes, such as thickness.

For information on the matrix, see “[matrix \(Product Model Matrix\)](#)” on page 51.

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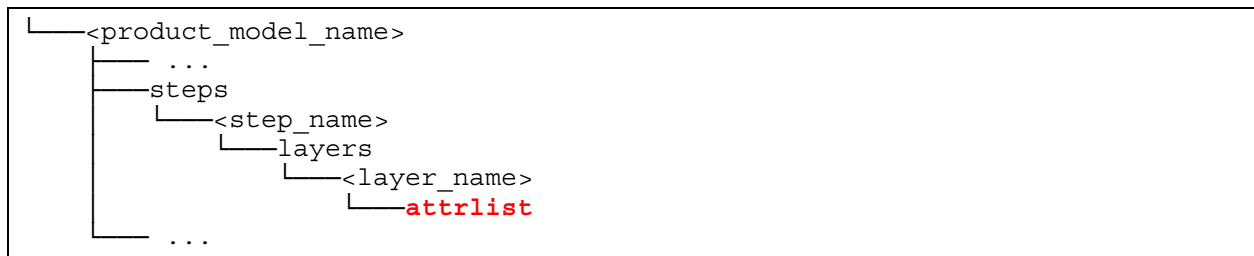
<layer_name>/attrlist (Layer Attribute List)

This file contains the values for system attributes and user-defined attributes of a layer.

You can provide *attrlist* files at these levels: product model, symbol, wheel, step, layer.

attrlist (Attribute List)	
Type	Structured Text
Compression	None
Path	<product_model_name>/steps/<step_name>/layers/<layer_name>/attrlist
UNITS	The UNITS directive is required.

System attributes that can be placed in this file are listed with Entity = Layer in the attribute description. See “[System Attributes](#)” on page 215.



The file contains lines of this form: <attribute> = <value>

Example of a layer attrlist file

```

UNITS=MM
.out_mirror = no
.inp_file =
.eda_layers = "signal_2","signal","VIA"
.out_angle = 0.0
.out_polarity = positive
.out_x_scale = 1.000000
.out_y_scale = 1.000000
.out_comp = 0.000000

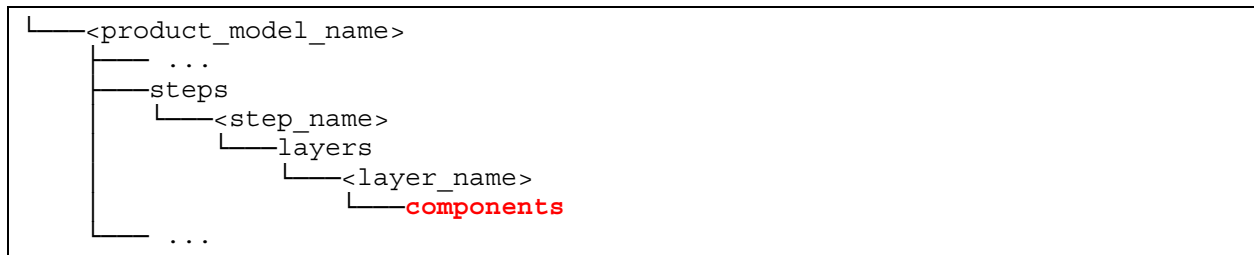
```


<layer_name>/components (Components)

Each layer of type component has a unique name: comp_+_top or comp_+_bot. There can be only one of each layer name within a product model—one for the top components and one for the bottom components.

components	
Type	Line Record Text
Compression	Yes
Path	<product_model_name>/steps/<step_name>/layers/<layer_name>/components
UNITS	The UNITS directive is required.

Each component layer has a *components* file that contains information about components placed on the layer. The components file contains references to the file <step_name>/eda/data. See “<step_name>/eda (Electronic Design Automation)” on page 108.



Example of a component file:

```
#
UNITS=INCH
#
#Component attribute names
#
@0 .no_pop
@1 .comp_ignore
@2 .desc1
@3 .comp_mount_type
@4 .comp_height
#
#Component attribute text strings
#
&0 Internally created connector
&1 Socket
&2 ball
&3 gw

# CMP 0
CMP 0 1.55 8.9 270.0 N J10 2300046 ;0,2=0,3=1
PRP PART_NUMBER '1000045'
PRP VALUE 'FAN1654'
PRP PART_NUMBER '1000045'
TOP 0 6.568 5.2296 0.0 N 8 163 1
TOP 1 6.568 5.204 0.0 N 8 164 2
TOP 2 6.568 5.1784 0.0 N 13 66 3
TOP 3 6.568 5.1528 0.0 N 2 779 4
TOP 4 6.568 5.1272 0.0 N 2 780 5
TOP 5 6.568 5.1016 0.0 N 13 67 6
TOP 6 6.568 5.076 0.0 N 8 165 7
TOP 7 6.568 5.0504 0.0 N 2 781 8
TOP 8 6.798 5.0504 0.0 N 1494 0 9
TOP 9 6.798 5.076 0.0 N 13 68 10
TOP 10 6.798 5.1016 0.0 N 12 1 11
TOP 11 6.798 5.1272 0.0 N 1143 1 12
TOP 12 6.798 5.1528 0.0 N 2 782 13
TOP 13 6.798 5.1784 0.0 N 1144 1 14
TOP 14 6.798 5.204 0.0 N 8 166 15
TOP 15 6.798 5.2296 0.0 N 1495 0 16
TOP 16 6.683 5.14 0.0 N 2 783 17
#
# BOM DATA
CPN M62X971EL7
PKG
IPN
DSC 16-ETSSOP FAN1654
VPL_VND MOTOROLA
VPL_MPN MC74HC259ADT
#COMP_EXT_PTY 1
VND MOTOROLA INC.
MPN 0 Y MC74HC259ADT
# CMP 1
CMP 3 5.017 1.791 180.0 N C400 ??? ;3=1
PRP VOLTAGE '6.3V'
PRP VALUE '22UF'
```

```
TOP 0 5.072 1.791 180.0 N 87 2 1
TOP 1 4.962 1.791 180.0 N 2 245 2
#
# BOM DATA
CPN IZZ5FH7FX7
PKG
IPN
DSC B3258 22UF 6.3V
VPL_VND
VPL_MPN
#COMP_EXT_PTY 1
VND KOA
MPN 0 Y TMC1AABA106K
```

Component File Section	Description
@ and & — Component Attribute Lookup Table	This section of the component file contains a table of component attribute names and a table of all component attribute values that are strings.
CMP — Component Record	This record contains the definition of a component. Each CMP line is followed by 0 or more property (PRP) records, and 0 or more TOP records. The pkg_ref field of the CMP record references the sequential order of the PKG records in the <i>eda/data</i> file. PKG order is referenced using numbers starting from 0 and up.
PRP — Component Property Record	This record represents a property of the component. A property consists of a name, a string value, and 0 or more floating numbers.
TOP — Component Toeprint Record	This record contains a definition of a toeprint of a component.
BOM Description Records	The BOM DATA section of a component file contains BOM information for components.

@ and & — Component Attribute Lookup Table

This section of the component file contains a table of component attribute names and a table of all component attribute values that are strings.

- **Component attribute names** — Each record contains an at sign (@), an index, and an attribute name. For example, @1 .comp_ignore.
- **Feature attribute text strings** — Each record contains an ampersand (&), an index, and a text string that can be used as the value of an attribute of type TEXT. For example, &3 gw.

System attributes that can be placed in this table are listed with Entity = Comp. in the attribute description. See “[System Attributes](#)” on page 215.

This section must be placed before the first CMP record of the file.

The CMP records in the file can assign component attributes by referencing the index of a component attribute and, for attributes of type TEXT, the index of the text string that is the value assigned to the attribute.

This is an example of a component attribute lookup table, and a CMP record that assigns attributes. The string 0,2=0,3=1 in the CMP record in the example should be interpreted as assigning these attributes to the component:

```
#Component attribute names
#
@0 .no_pop
@1 .comp_ignore
@2 .desc1
@3 .comp_mount_type
@4 .comp_height
#
#Component attribute text strings
#
&0 Internally created connector
&1 Socket
&2 ball
&3 gw

# CMP 0
CMP 0 1.55 8.9 270.0 N J10 2300046 ;0,2=0,3=1
```

Assignment in the CMP Record	Line in the Table of Attribute Names	Attribute Type	Line in the Table of Attribute Text Strings	Result
0	@0 .no_pop	BOOLEAN	-	.no_pop = TRUE
2=0	@2 .desc1	TEXT	&0 Internally created connector	.desc1 = Internally created connector
3=1	@3 .comp_mount_type	OPTION	-	.comp_mount_type = SMT Options for the .comp_mount_type attributes are: Other, SMT, THMT, PressFit, so 1 indicates SMT.

CMP — Component Record

This record contains the definition of a component. Each CMP line is followed by 0 or more property (PRP) records, and 0 or more TOP records. The pkg_ref field of the CMP record references the sequential order of the PKG records in the *eda/data* file. PKG order is referenced using numbers starting from 0 and up.

See “[PKG — Package Record](#)” on page 116.

This is the format of the CMP component record:

CMP <pkg_ref> <x> <y> <rot> <mirror> <comp_name> <part_name>; <attributes>;ID=<id>

Field	Explanation
pkg_ref	Reference number of the package in the <i>eda/data</i> file. See “ <step_name>/eda (Electronic Design Automation) ” on page 108.
x, y	Board location of the component in inches or mm.
rot	Rotation of the component, in degrees, clockwise.
mirror	N for not mirrored, M for mirrored.
comp_name	Unique reference designator (component name); a single string of ASCII characters without spaces. Upper case and lower case characters are not equivalent.
part_name	Part identification is a single string of ASCII characters without spaces.
attributes	A comma separated list of attribute assignments. The attribute is indicated by its index in the attribute name lookup table. <ul style="list-style-type: none"> • BOOLEAN — n indicating that attribute n is set. • OPTION — n=m indicating that attribute n has value m. • INTEGER — n=i indicating that attribute n has value i. • FLOAT — n=f indicating that attribute n has value f. • TEXT — n=s indicating that attribute n has the value associated with index s in the attribute text string lookup table. See “ @ and & — Component Attribute Lookup Table ” on page 155.
ID=<id>	Assigns a unique identifier to the component. See “ Unique ID ” on page 30.

PRP — Component Property Record

This record represents a property of the component. A property consists of a name, a string value, and 0 or more floating numbers.

The PRP file has this format:

PRP <name> '<value>' n1 n2 ...,

Field	Explanation
name	Name of the property.
value	String of the property (between quotes; no restrictions).
n1,n2,...	Floating numbers to be kept in the property.

TOP — Component Toeprint Record

This record contains a definition of a toeprint of a component.

This is the format of the TOP record:

TOP <pin_num> <x> <y> <rot> <mirror> <net_num> <subnet_num> <toeprint_name>,

Field	Explanation
pin_num	Pin number inside the package of the component.
x, y	Board location of the pin in inches or mm.
rot	Rotation of the component, in degrees, clockwise.
mirror	N for not mirrored, M for mirrored.
net_num	Number of net in the <i>eda/data</i> file. The net_num used in the TOP record corresponds to the sequence of the NET records in the <i>eda/data</i> file. The first NET record is net_num 0, the second is net_num 1 and so on.
subnet_num	Number of subnet (SNT record) in the referenced net.
toeprint_name	Name of the toeprint.

BOM Description Records

The BOM DATA section of a component file contains BOM information for components.

Parameter	Description
CPN	Customer part number.
PKG	Package name.
IPN	Internal part number.
DSC	Unlimited number of descriptions.

Parameter	Description
VPL_VND	Manufacturer from an external vendor part library corresponding to original vendor (as determined in BOM Validation).
VPL_MPN	MPN from an external vendor part library corresponding to original MPN (as determined in BOM Validation).
VND	Manufacturer (vendor) name.
MPN	<p>Manufacturer part number.</p> <p>The MPN lines contain these parameters separated by spaces:</p> <ul style="list-style-type: none"> • qualify status — Whether the part (vendor+mpn) is qualified for production: <ul style="list-style-type: none"> • -1 — Not qualified. • 0 — Unknown. • 1 — Qualified. • chosen status — Whether the part is chosen from among the alternate parts for the CPN. Only one part can be a chosen part. <ul style="list-style-type: none"> • 0 — Not chosen. • 1 — Chosen. • MPN — The manufacturer part number. <p>For example, MPN 0 Y 4N35S for a CPN component whose qualification is unknown (0), that is the chosen component (1), with a manufacturer part number of 4N35S.</p>

Example of Alternate Parts

This is an example of alternate parts defined for the same CPN. The first is chosen, and the third is not qualified. These sections repeat for all the alternate parts of the CPN: VPL_VND, VPL_MPN, VND, and MPN.

CPN 69K9KMH12B
LNFILE 51 name_of_bom_file.txt
VPL_MPN MAX5156ACEE
VPL_VND MAXIM
MPN MAX5156ACEE
LNFILE 51 name_of_bom_file.txt
VND MAXIM
LNFILE 51 name_of_bom_file.txt
QLF 0
CHS 1
PRIORITY 1

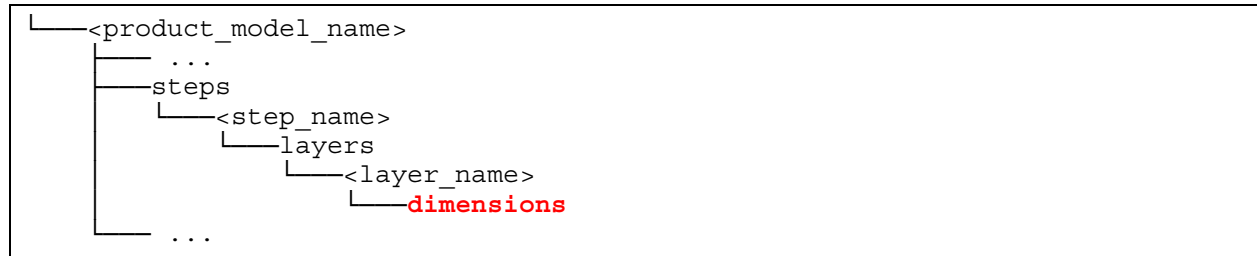
CPN 69K9KMH12B
LNFILE 51 name_of_bom_file.txt
VPL_MPN CY22150FC
VPL_VND CYPRESS
MPN CY22150FC
LNFILE 52 name_of_bom_file.txt
VND CYPRESS
LNFILE 52 name_of_bom_file.txt
QLF 0
CHS 0
PRIORITY 2

CPN 69K9KMH12B
LNFILE 51 name_of_bom_file.txt
VPL_MPN AT93C66-10SC
VPL_VND ATMEL
MPN AT93C66-10SC
LNFILE 53 name_of_bom_file.txt
VND ATMEL
LNFILE 53 name_of_bom_file.txt
QLF -1
CHS 0
PRIORITY 0

<layer_name>/dimensions (Dimensions)

Dimensions that have been added to a layer to indicate measurements of objects on the layer are stored with the product model.

dimensions (Dimensions)	
Type	Structured Text
Compression	Yes
Path	<i><product_model_name>/steps/<step_name>/layers/<layer_name>/dimensions</i>
UNITS	The UNITS directive is required.



Example of a Dimensions File:

```

VERSION=1
UNITS=INCH
PARAMETERS {
  ID=0
  LINE_WIDTH=0.01
  POST_DECIMAL_DIST=3
  POST_DECIMAL_POS=3
  POST_DECIMAL_ANGLE=1
  FONT=STANDARD
  FONT_WIDTH=0.07
  FONT_HEIGHT=0.05
  EXT_OVERLEN=0.02
  EXT_OFFSET=0.01
  CENTER_MARKER_LEN=0.05
  BASELINE_SPACING=0.012
  ORIGIN_X=0
  ORIGIN_Y=0
  SCALE=100
  PAPER {
    ORIENTATION=PORTRAIT
    SIZE=A4
    WIDTH=8.3
    HEIGHT=11.7
    X=0
    Y=0
    MARGIN {
      TOP=0.1
      BOTTOM=0.1
      LEFT=0.2
      RIGHT=0.2
    }
    ACTIVE {
      X00=1
      Y00=1
      X11=8
      Y11=11
    }
    COLOR {
      FEATURE=RED
      DIMENS=BLUE
      DIMENS_TEXT=GREEN
      PROFILE=BLACK
      TEMPLATE=GRAY
    }
  }
}
DIMENSION {
  TYPE=HORIZONTAL
  PARAMETERS=0
  REF1X=0.1
  REF1Y=0.2
  REF2X=1.2
  REF2Y=0.3
  REF3X=0
  REF3Y=0
  LINE_PT_X=1.2

```

```

LINE_PT_Y=0.7
OFFSET=0
ARROW_POS=AUTOMATIC
MAGNIFY=1
TO_ARC_CENTER=NO
TWO_SIDED_DIAM=NO
TEXT {
    VALUE=27.94
    PREFIX=
    SUFFIX=
    NOTE=
    UNITS=MM
    VIEW_UNITS=YES
    OUTSIDE=NO
    UNDERLINE=NO
    TOL_UP=
    TOL_DOWN=
    MERGE_TOL=NO
    X=0.65
    Y=0.7
    ANGLE=0
}
DIMENSION {
    TYPE=VERTICAL
    PARAMETERS=0
    REF1X=0.3
    REF1Y=0.8
    REF2X=0.3
    REF2Y=0.1
    REF3X=0
    REF3Y=0
    LINE_PT_X=-0.1
    LINE_PT_Y=0.1
    OFFSET=0
    ARROW_POS=AUTOMATIC
    MAGNIFY=1
    TO_ARC_CENTER=NO
    TWO_SIDED_DIAM=NO
    TEXT {
        VALUE=17.78
        PREFIX=
        SUFFIX=
        NOTE=
        UNITS=MM
        VIEW_UNITS=YES
        OUTSIDE=YES
        UNDERLINE=NO
        TOL_UP=
        TOL_DOWN=
        MERGE_TOL=NO
        X=-0.1
        Y=-0.15231
        ANGLE=90
    }
}
DIMENSION {
    TYPE=PARALLEL
    PARAMETERS=0
    REF1X=0.3

```

```

REF1Y=-0.2
REF2X=0.6
REF2Y=-0.5
REF3X=0
REF3Y=0
LINE_PT_X=0.7
LINE_PT_Y=-0.4
OFFSET=0
ARROW_POS=AUTOMATIC
MAGNIFY=1
TO_ARC_CENTER=NO
TWO_SIDED_DIAM=NO
TEXT {
    VALUE=10.776
    PREFIX=
    SUFFIX=
    NOTE=
    UNITS=MM
    VIEW_UNITS=YES
    OUTSIDE=YES
    UNDERLINE=NO
    TOL_UP=
    TOL_DOWN=
    MERGE_TOL=NO
    X=1.0021572
    Y=-0.702157
    ANGLE=45
}

```

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PARAMETERS Array Structure.....	165
DIMENSION Array Structure.....	166
PAPER Array Structure	167
TEXT Array Structure	168

Global Parameters for Dimensions

These are the global parameters.

Field	Explanation
VERSION	File version. <int>, >= 0
UNITS	Units of all coordinates and floating numbers. <string> Possible values: INCH MM

PARAMETERS Array Structure

This is the array structure of each parameter set.

Field	Explanation
ARROW_STYLE	Controls the appearance of the dimension arrow. Optional. <int>, >= 0
ID	The ID of this parameter set. DIMENSION records reference parameter sets by this number. See “ DIMENSION Array Structure ” on page 166. <int>, >= 0
LINE_WIDTH	Dimension line width. <float>, 0 - 500 mil
POST_DECIMAL_DISTANCE	Number of decimal digits for size type dimensions. <int>, 0 - 6
POST_DECIMAL_POSITION	Number of decimal digits for LOCATION type dimensions. <int>, 0 - 6
POST_DECIMAL_ANGLE	Number of decimal digits for ANGLE type dimensions. <int>, 0 - 6
FONT	Name of a font from the fonts folder of the product model. <string>
FONT_WIDTH	Width of text letters. <float>, 0 - 5000 mil
FONT_HEIGHT	Height of text letters. <float>, 0 - 5000 mil
EXT_OVERLEN	Extension overlength for HORIZONTAL VERTICAL PARALLEL ANGLE. <float>, -100 INCH - 100 INCH
EXT_OFFSET	Extension offset for HORIZONTAL VERTICAL PARALLEL ANGLE. <float>, -100 INCH - 100 INCH
CENTER_MARKER_LEN	Cross size for CENTER dimension. <float>, 0 - 100 INCH
BASELINE_SPACING	Spacing for HORIZONTAL, VERTICAL, PARALLEL. <float>, 0 - 100 INCH
ORIGIN_X	<x coordinate>, -100 INCH - 100 INCH

Field	Explanation
ORIGIN_Y	<y coordinate>, -100 INCH - 100 INCH
SCALE	Frontline scaling percent. <float>, 0 - 100
PAPER	The PAPER array. See “ PAPER Array Structure ” on page 167.

DIMENSION Array Structure

This is the dimension array structure.

Field	Explanation
TYPE	<string> Possible values: HORIZONTAL VERTICAL PARALLEL RADIUS DIAMETER CHAMFER CENTER LOCATION ANGLE
PARAMETERS	The ID number of a parameter set. See “ PARAMETERS Array Structure ” on page 165. <int>
REF1X	<x coordinate>, -100 INCH - 100 INCH
REF1Y	<y coordinate>, -100 INCH - 100 INCH
REF2X	<x coordinate>, -100 INCH - 100 INCH Not relevant to CENTER.
REF2Y	<y coordinate>, -100 INCH - 100 INCH Not relevant to CENTER.
REF3X	<x coordinate>, -100 INCH - 100 INCH Relevant to RADIUS, DIAMETER, CHAMFER, LOCATION, ANGLE.
REF3Y	<y coordinate>, -100 INCH - 100 INCH Relevant to RADIUS, DIAMETER, CHAMFER, LOCATION, ANGLE.
LINE_PT_X	<x coordinate>, -100 INCH - 100 INCH Not relevant to CENTER.
LINE_PT_Y	<y coordinate>, -100 INCH - 100 INCH Not relevant to CENTER.
OFFSET	Offset for RADIUS, DIAMETER, CHAMFER, LOCATION. <float>, -100 INCH - 100 INCH

Field	Explanation
ARROW_POS	<string> Possible values: AUTOMATIC INSIDE OUTSIDE
MAGNIFY	Frontline magnification percent. <float>, 0 - 100
TEXT	The TEXT array. See “ TEXT Array Structure ” on page 168.
TO_ARC_CENTER	<string> Possible values: NO YES Relevant to RADIUS, DIAMETER.
TWO_SIDED_DIAM	<string> Possible values: NO YES Relevant to RADIUS, DIAMETER.

PAPER Array Structure

This is the array structure for the Frontline paper definitions. It is included in the PARAMETERS array.

Field	Explanation
ORIENTATION	<string> Possible values: NONE PORTRAIT LANDSCAPE
SIZE	<string> Possible values for the Postscript paper size: A0 A1 A2 A3 A4 A5 B4 B5 LETTER LIFE CUSTOM
WIDTH	<float>
HEIGHT	<float>
X	<float>
Y	<float>
MARGIN	The MARGIN array contains this information: TOP = <float> BOTTOM = <float> LEFT = <float> RIGHT = <float>

Field	Explanation
ACTIVE	The ACTIVE array contains this information: X00 = <float> Y00 = <float> X11 = <float> Y11 = <float>
COLOR	The COLOR array contains this information: FEATURE = <string> DIMENS = <string> DIMENS_TEXT = <string> PROFILE = <string> TEMPLATE = <string>

TEXT Array Structure

The TEXT array structure is not relevant to the CENTER dimension. It is included in the DIMENSIONS array.

Field	Explanation
PREFIX	<string>, 0-20 characters
SUFFIX	<string>, 0-20 characters
VALUE	<string>, 0-40 characters
NOTE	<string>, 0-100 characters
UNITS	<string> Possible values: INCH MM MIL MICRON DEGREE Radian GRADIAN Options DEGREE, Radian, and GRADIAN are relevant to ANGLE only.
VIEW_UNITS	<string> Possible values: NO YES
TOL_UP	<string>, 0-11 characters
TOL_DOWN	<string>, 0-11 characters
MERGE_TOL	<string> Possible values: NO YES

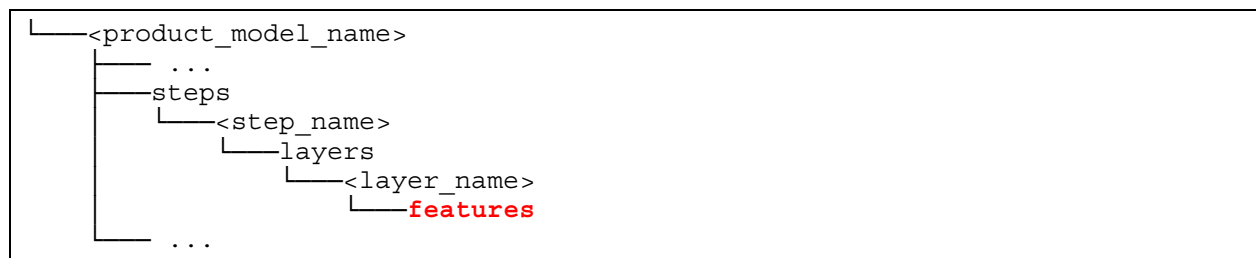
Field	Explanation
OUTSIDE	<string> Possible values: NO YES Not relevant to LOCATION.
UNDERLINE	<string> Possible values: NO YES Relevant to RADIUS, DIAMETER, CHAMFER.
X	<x coordinate>, -100 INCH - 100 INCH
Y	<y coordinate>, -100 INCH - 100 INCH
ANGLE	<float>, 0-360 degrees

<layer_name>/features (Graphic Features)

The features file contains definitions of graphic features.

features	
Type	Line Record Text
Compression	Yes
Path	<product_model_name>/steps/<step_name>/layers/<layer_name>/features
UNITS	The UNITS directive is required.

The *features* file contains most of the graphic information representing the physical board layers, NC drill and rout layers, and miscellaneous drawings. The *features* file should be present only for layers of these types.



User-defined symbols have a *features* file to describe their shape. See “[symbols \(User-Defined Symbols\)](#)” on page 94.

The files defining a step profile or a layer profile have the same format as a *features* file. The file defines a single surface feature:

- “<step_name>/profile (Outline Shape of Step)” on page 141
- “<layer_name>/profile (Outline Shape of Layer)” on page 188

Example of a features file:

```

UNITS=MM
ID=216
#
#Num Features
#
F 1406
#
#Feature symbol names
#
$0 r120
$1 rect20x60 M
$2 rect3x5 I
$3 punch_target
#
#Feature attribute names
#
@0 .smd
@1 .nomenclature
@2 .test_point
@3 .geometry
@4 .pad_usage
#
#Feature attribute text strings
#
&0 9796334
&1 fid_0_0_0
&2 moire
&3 p115_115_115_095
#
#Layer features
#
P -0.198 1.62 16 P 0 3;3=2,4=0;ID=123456
P 0.118 1.62 16 P 0 3;3=25,4=0;ID=5678
L 3.834 -1.16 3.86728 -1.16 2 P 0 ;1,3=0
L 3.86728 -1.16 3.8782 -1.16485 2 P 0 ;1,3=0

...

S P 0;ID=123456
OB -0.013 2.427 I
OS -0.013 2.218
OS -0.263 2.218
OS -0.263 2.427
OS -0.219 2.427
OS -0.219 2.262
OS -0.057 2.262
OS -0.057 2.427
OS -0.013 2.427
OE
SE
...

```

The file consists of the UNITS, ID, and F records, a section that lists symbol names, an attribute lookup table, and lines or structures defining the various types of features.

Section	Description
UNITS — Measurement Units	Features and coordinates are saved in the units in which they were created, to avoid loss of precision due to rounding.
ID — Unique ID (Optional)	This file can contain a unique ID.
F — Number of Features (Optional)	An optional line of the <i>features</i> file indicates the actual number of feature records that there are in the file. If available, this information could be used to determine what actions to take when reading the <i>features</i> file content.
\$ — Feature Symbol Names Section	This section lists the symbols used to construct lines, pads, or arcs defined in the file. It contains the names of all the symbols used by the features in the file and corresponding serial numbers for reference by the feature records.
@ and & — Feature Attribute Lookup Table	This section of the file contains a table of feature attribute names and a table of all feature attribute values that are strings. The feature definition records can assign attributes by referencing the index of an attribute and, for attributes of type TEXT, the index of the text string that is the value assigned to the attribute.
L — Line Records	These records define a line.
P — Pad Records	These lines define a pad.
A — Arc Records	These lines define an arc.
T — Text Records	These lines define text.
B — Barcode Records	These records define a barcode.
S — Surface Records	A surface definition must have at least one polygon defined. The surface usually consists of multiple records.

UNITS — Measurement Units

Features and coordinates are saved in the units in which they were created, to avoid loss of precision due to rounding.

In every *features* file, there must be a UNITS directive that indicates the units of measurement to be applied to the features in the file. See “[Units of Measurement](#)” on page 23.

This is the format of the line: UNITS=<MM_or_INCH>.

- **UNITS=MM** — Indicates that metric units of measurement are used in the file.
- **UNITS=INCH** — Indicates that imperial units of measurement are used in the file.

If the UNITS directive does not exist in the *features* file, the units defined for the product model are assumed. If the *misc/info* file of the product model does not contain a UNITS directive, imperial units are assumed.

All coordinate values will be interpreted as inches or millimeters. Resize factors for user-defined symbols are interpreted as mils or microns. Exceptions are discussed where relevant.

This also applies to semi-standard symbols described in the *features* file. See “\$ — Feature Symbol Names Section” on page 174.

The UNITS directive in the *features* file sets the units to be used for symbols that do not specify units. In the example, units of measurement are set to metric.

Example of Interpretation of Symbol Dimensions

```
#
UNITS=MM
#
#Feature symbol names
#
$0 r120
$1 rect20x60 M
$2 rect3x5 I
$3 punch_target
...

```

In the example, the units of measurement are specified for the file and also for some of the symbols:

- **r120** — Standard round symbol with units in microns.
- **rect20x60 M** — Standard rectangle symbol with units in microns. X is 20 microns and Y is 60 microns.
- **rect3x5 I** — Standard rectangle with units in mils. X is 3 mils and Y is 5 mils.
- **punch_target** — User-defined symbol. This must exist in the symbol directory of the product model.

ID — Unique ID (Optional)

This file can contain a unique ID.

This is the format of the line: ID=<id>.

See “Unique ID” on page 30.

F — Number of Features (Optional)

An optional line of the *features* file indicates the actual number of feature records that there are in the file. If available, this information could be used to determine what actions to take when reading the *features* file content.

This is the format of the line: F <number_of_features>.

\$ — Feature Symbol Names Section

This section lists the symbols used to construct lines, pads, or arcs defined in the file. It contains the names of all the symbols used by the features in the file and corresponding serial numbers for reference by the feature records.

This is the format of the line: \$<serial_num> <symbol_name> [<I|M>]

The parameter I or M can be added at the end of the line to indicate that the dimensions in this symbol name are expressed in imperial units or metric units.

Each line, pad, or arc feature definition record lists the index of the symbol used to construct that feature.

For a list of standard symbol names, see “[Standard ODB++ Symbols](#)” on page 195.

Example of the Feature Symbol Names Section

```
#
#Feature symbol names
#
$0 r120
$1 rect20x60 M
$2 rect3x5 I
$3 punch_target
```

@ and & — Feature Attribute Lookup Table

This section of the file contains a table of feature attribute names and a table of all feature attribute values that are strings. The feature definition records can assign attributes by referencing the index of an attribute and, for attributes of type TEXT, the index of the text string that is the value assigned to the attribute.

- **Feature attribute names** — Each record contains an at sign (@), an index, and an attribute name. For example, @1 .nomenclature.
- **Feature attribute text strings** — Each record contains an ampersand (&), an index, and a text string that can be used as the value of an attribute of type TEXT. For example, &2 moire.

System attributes that can be placed in this table are listed with Entity = Feature in the attribute description. See “[System Attributes](#)” on page 215

This section must be placed before the layer features section of the file.

The feature definition records in the file can assign feature attributes by referencing the index of a feature attribute and, for attributes of type TEXT, the index of the text string that is the value assigned to the attribute.

Example of a Feature Attribute Lookup Table

This is an example of a feature attribute lookup table, and a feature definition record that assigns attributes:

```
#
#Feature attribute names
#
@0 .smd
@1 .nomenclature
@2 .test_point
@3 .geometry
@4 .pad_usage
#
#Feature attribute text strings
#
&0 9796334
&1 fid_0_0_0
&2 moire
&3 p115_115_115_095
#
#Layer features
#
P -0.198 1.62 16 P 0 3;3=2,4=0;ID=123456
```

The string 3=2,4=0 in the feature definition record in the example should be interpreted as assigning these attributes to the feature:

Feature Definition Record Assignment	Line in the Table of Attribute Names	Attribute Type	Line in the Table of Attribute Text Strings	Result
3=2	@3 .geometry	TEXT	&2 moire	.geometry = moire
4=0	@4 .pad_usage	OPTION	-	.pad_usage = toepoint Options for the .pad_usage attribute are: toepoint; via; g_fiducial; l_fiducial; tooling_hole, so 0 indicates toepoint.

L — Line Records

These records define a line.

This is the format of a line record:

L <xs> <ys> <xe> <ye> <sym_num> <polarity> <dcode>;<atr>=<value>,...;ID=<id>

Line Record Parameter	Explanation
type	L
xs, ys	Start point.
xe, ye	End point.
sym_num	The index of the feature used to construct the line, in the feature symbol names section. See “ \$ — Feature Symbol Names Section ” on page 174.
polarity	P — Positive. N — Negative.
dcode	Gerber dcode number or Excellon tool number (0 if not defined).
atr	An attribute number, referencing an attribute from the feature attribute names section. See “ @ and & — Feature Attribute Lookup Table ” on page 174.
value	An attribute value that depends on the type of attribute: <ul style="list-style-type: none">• BOOLEAN — No value is necessary. If the index of the attribute is listed, the attribute is set to TRUE.• FLOAT or INTEGER — A number.• OPTION — An option number.• TEXT — A number referencing the feature attribute text strings section. See “@ and & — Feature Attribute Lookup Table” on page 174.
ID=<id>	Assigns a unique identifier to the feature. See “ Unique ID ” on page 30.

Example of a Line Record in a Features File

```
L 5.15 0.35 5.125 0.325 0 P 0
```

P — Pad Records

These lines define a pad.

This is the format of a line record:

P <x> <y> <apt_def> <polarity> <dcode> <orient_def>;<atr>=<value>,...;ID=<id>

Pad Parameter	Explanation
x, y	Center point.
apt_def	<p>The index, in the feature symbol names section, of the symbol to be used to draw the pad.</p> <p>This value can be expressed in one of these ways:</p> <ul style="list-style-type: none"> • <sym_num> — The symbol with index <sym_num> is used as is. • -1 <sym_num> <resize_factor> — The symbol with index <sym_num> is enlarged or shrunk by factor <resize_factor>. The resize factor is expressed in thousandths of the units being used (mils or microns). <p>See “\$ — Feature Symbol Names Section” on page 174.</p>
polarity	<p>P — Positive.</p> <p>N — Negative.</p>
dcode	Gerber dcode number or Excellon tool number (0 if not defined).
orient_def	<p>Pad orientation.</p> <p>This value is expressed as: 0 1 2 3 4 5 6 7 8<rotation> 9<rotation></p> <p>If the first number of orientation definition is an integer from 0 through 7, it is legacy data and will be handled accordingly. These values are read from legacy data to maintain backward compatibility.</p> <p>0 — 0 degrees rotation, no mirror. 1 — 90 degrees rotation, no mirror. 2 — 180 degrees rotation, no mirror. 3 — 270 degrees rotation, no mirror. 4 — 0 degrees rotation, mirror in x-axis. 5 — 90 degrees rotation, mirror in x-axis. 6 — 180 degrees rotation, mirror in x-axis. 7 — 270 degrees rotation, mirror in x-axis.</p> <p>If the first number is 8 or 9, it is a two number definition, with the following number representing rotation.</p> <p>8 — Any angle rotation, no mirror. 9 — Any angle rotation, mirror in x-axis.</p> <p>When pads are both rotated and mirrored, they are rotated first, and then mirrored along the x-axis.</p>

Pad Parameter	Explanation
atr	An attribute number, referencing an attribute from the feature attribute names section. See “@ and & — Feature Attribute Lookup Table” on page 174.
value	An attribute value that depends on the type of attribute: <ul style="list-style-type: none"> • BOOLEAN — No value is necessary. If the index of the attribute is listed, the attribute is set to TRUE. • FLOAT or INTEGER — A number. • OPTION — An option number. • TEXT — A number referencing the feature attribute text strings section. See “@ and & — Feature Attribute Lookup Table” on page 174.
ID=<id>	Assigns a unique identifier to the feature. See “Unique ID” on page 30.

Example of Pad Records in a Features File

Special pad const_1 at location x=1.0, y=2.0 positive, with dcode 4, is used as an example for different transformations:

```
#
#Feature symbol names
#
$0 const_1
#
#Feature attribute names
#
@0 .smd
1 .nomenclature
2 .test_point
3 .geometry
4 .pad_usage
.....
#

P 1.0 2.0 0 P 4 1;;ID=3948
P 1.0 2.0 0 P 4 8 30.0;;ID=7205
P 1.0 2.0 -1 0 0.02 P 4 1;;ID=7421
P 1.0 2.0 -1 0 0.02 P 4 8 30.0;;ID=9630
```

In the example,

P 1.0 2.0 0 P 4 1 is rotated by 90 degrees (orient_def = 1).

P 1.0 2.0 0 P 4 8 30.0 is rotated by 30 degrees (orient_def = 8 30.0).

P 1.0 2.0 -1 0 0.02 P 4 1 is rotated by 90 degrees, and resized by 0.02 mil (apt_def = -1 0 0.02 and orient_def = 1).

P 1.0 2.0 -1 0 0.02 P 4 8 30.0 is rotated by 30, and resized by 0.02 mil (apt_def = -1 0 0.02 and orient_def = 8 30.0).

A — Arc Records

These lines define an arc.

This is the format of an arc definition record:

A <xs> <ys> <xe> <ye> <xc> <yc> <sym_num> <polarity> <dcode>
<cw>;<atr>=<value>,...;ID=<id>

Arc Parameter	Explanation
xs, ys	Start point. When the start and end-point of an arc coincide, it is considered a 360 degree arc. There are no single-point arcs in ODB++ format.
xe, ye	End point. When the start and end-point of an arc coincide, it is considered a 360 degree arc. There are no single-point arcs in ODB++ format.
xc, yc	Center point.
sym_num	The index, in the feature symbol names section, of the symbol to be used to draw the arc. See “\$ — Feature Symbol Names Section” on page 174.
polarity	P for positive, N for negative.
dcode	Gerber dcode number or Excellon tool number (0 if not defined).
cw	Y for clockwise, N for counter clockwise.
atr	An attribute number, referencing an attribute from the feature attribute names section. See “@ and & — Feature Attribute Lookup Table” on page 174.
value	An attribute value that depends on the type of attribute: <ul style="list-style-type: none"> • BOOLEAN — No value is necessary. If the index of the attribute is listed, the attribute is set to TRUE. • FLOAT or INTEGER — A number. • OPTION — An option number. • TEXT — A number referencing the feature attribute text strings section. See “@ and & — Feature Attribute Lookup Table” on page 174.
ID=<id>	Assigns a unique identifier to the feature. See “Unique ID” on page 30.

Example of an Arc Record in a Features File

```
A 1.49401033 2.53683297 0.8389936 2.48563819 1.17858858 2.35659203 2 P 0 Y
```

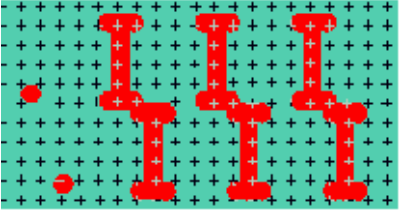
T — Text Records

These lines define text.

This is the format of a text definition record:

```
T <x> <y> <font> <polarity> <orient_def> <xsize> <ysize> <width_factor> <text>  
<version>;<atr>=<value>,...;ID=<id>
```

Text Parameter	Explanation
x, y	Text location (bottom left of first character for 0 orientation).
font	Font name.
polarity	P for positive, N for negative.
orient_def	<p>Text orientation.</p> <p>This value is expressed as: 0 1 2 3 4 5 6 7 8<rotation> 9<rotation></p> <p>If the first number of orientation definition is an integer from 0 through 7, it is legacy data and will be handled accordingly. These values are read from legacy data to maintain backward compatibility.</p> <p>0 — 0 degrees rotation, no mirror. 1 — 90 degrees rotation, no mirror. 2 — 180 degrees rotation, no mirror. 3 — 270 degrees rotation, no mirror. 4 — 0 degrees rotation, mirror in x-axis. 5 — 90 degrees rotation, mirror in x-axis. 6 — 180 degrees rotation, mirror in x-axis. 7 — 270 degrees rotation, mirror in x-axis.</p> <p>If the first number is 8 or 9, it is a two number definition, with the following number representing rotation.</p> <p>8 — Any angle rotation, no mirror. 9 — Any angle rotation, mirror in x-axis.</p> <p>When pads are both rotated and mirrored, they are rotated first, and then mirrored along the x-axis.</p>
xsize, ysize	<p>Character size.</p> <p>xsize — Character width including the following space. ysize — Height of a capital character</p>

Text Parameter	Explanation
width_factor	The width of character segment (in units of 12 mils); that is, 1 = 12 mils, 0.5 = 6 mils
text	Text string enclosed in single quotes. The text string can contain dynamic text variables such as \$\$DATE.
version	<p>Defines how the first character of a text string is to be placed relative to the insertion point.</p> <p>0 — Lower left corner of the text limit box coincides with the insertion point.</p> <p>1 — Lower left corner of the widest character coincides with the insertion point. (The widest character is usually an M or a W, by which smaller letters are centered.)</p>  <p>The first row of text has this parameter set to 0. The second row has it set to 1.</p>
atr	An attribute number, referencing an attribute from the feature attribute names section. See “ @ and & — Feature Attribute Lookup Table ” on page 174.
value	<p>An attribute value that depends on the type of attribute:</p> <ul style="list-style-type: none"> • BOOLEAN — No value is necessary. If the index of the attribute is listed, the attribute is set to TRUE. • FLOAT or INTEGER — A number. • OPTION — An option number. • TEXT — A number referencing the feature attribute text strings section. See “@ and & — Feature Attribute Lookup Table” on page 174.
ID=<id>	<p>A unique identifier for the feature.</p> <p>See “Unique ID” on page 30.</p>

Dynamic Text Variables

A text string can include dynamic text variables that change textual value according to status or condition. For example, a variable for the date always displays the current date, as set by the system. Dynamic text variables can be located anywhere within a text string. They are distinguished by the prefix \$\$, as in \$\$DATE for the current date.

An example of a dynamic text record would be:

```
T 11.890963 13.697185 standard P 8 0 5.08 5.08 2.00000 '$$DATE-MMDDYY' 1
```

Where the variable \$\$DATE-MMDDYY displays the date as 05/30/17.

The ODB++ format supports these dynamic text variables:

Variable	Descriptions
DATE-MMDDYY	Date expressed as month/day/year (short).
DATE-DDMMYY	Date expressed as day/month/year (short).
DATE-MMDDYYYY	Date expressed as month/day/year.
DATE-DDMMYYYY	Date expressed as day/month/year.
DD	Day of month (01-31).
WEEK-DAY	Day of week (Sunday-Saturday).
MM	Month of year (01-14).
YY	Year (14).
YYYY	Year (2014).
WW	Week of year (01-52).
TIME	Current time.
JOB	Name of current product module.
STEP	Name of step where text is placed.
LAYER	Name of layer where text is placed.
X	Bottom left x-coordinate of where text is placed (inch).
Y	Bottom left y-coordinate of where text is placed (inch).
X_MM	Bottom left x-coordinate of where text is placed (mm).
Y_MM	Bottom left y-coordinate of where text is placed (mm).

Example of a Text Record in a Features File

```
#Feature attribute names
#
#Layer features
#
T 4.033375 6.377506 standard P 8 0 0.2 0.2 2.00000 '$$DATE-DDMMYY - Coupon
STD500CV' 1
```

The fields of the example record indicate this information:

Parameter	Value in Example	Explanation
Record type	T	The record is text.
Location	4.033375 6.377506	The x, y coordinates at the bottom left of the first character of the text string.
Font	standard	The font is standard
Polarity	P	The polarity is positive.
Orientation	8 0	The text is rotated but not mirrored (8) with 0 degrees of rotation.
Size	0.2 0.2	The x, y size of text string (by layer units).
Width factor	2.00000	The width of character segment is 24 mils.
Text string	'\$\$DATE-DDMMYY - Coupon STD500CV'	This text string contains a dynamic text variable. It contains a space.
Version	1	The lower left corner of the widest character coincides with the insertion point.

B — Barcode Records

These records define a barcode.

This is the format of the barcode definition line:

B <x> <y> <barcode> <polarity> <orient_def> E <w> <h> <fasc> <cs> <bg> <astr>
<astr_pos> <text>;<atr>=<value>,...;ID=<id>

Barcode Parameter	Explanation
x, y	Text location (bottom left of first character for 0 orientation.
barcode	Barcode name (currently must be UPC39).
font	Font name.
polarity	P for positive, N for negative.

Barcode Parameter	Explanation
orient_def	<p>Text orientation.</p> <p>This value is expressed as: 0 1 2 3 4 5 6 7 8<rotation> 9<rotation></p> <p>If the first number of orientation definition is an integer from 0 through 7, it is legacy data and will be handled accordingly. These values are read from legacy data to maintain backward compatibility.</p> <p>0 — 0 degrees rotation, no mirror. 1 — 90 degrees rotation, no mirror. 2 — 180 degrees rotation, no mirror. 3 — 270 degrees rotation, no mirror. 4 — 0 degrees rotation, mirror in x-axis. 5 — 90 degrees rotation, mirror in x-axis. 6 — 180 degrees rotation, mirror in x-axis. 7 — 270 degrees rotation, mirror in x-axis.</p> <p>If the first number is 8 or 9, it is a two number definition, with the following number representing rotation.</p> <p>8 — Any angle rotation, no mirror. 9 — Any angle rotation, mirror in x-axis.</p> <p>When pads are both rotated and mirrored, they are rotated first, and then mirrored along the x-axis.</p>
E	A constant value (reserved for future use).
w	Element width (inches or mm).
h	Barcode height (inches or mm).
fasc	Y for full ASCII, N for partial ASCII.
cs	Y for checksum, N for no checksum.
bg	Y for inverted background, N for no background.
astr	<p>Y for an addition of a text string; N for only the barcode</p> <div> </div> <p>The first barcode with Iver=0 text has this parameter set to Y; the second has this parameter set to N.</p>

Barcode Parameter	Explanation
astr_pos	T for adding the string on top, B for adding the string on the bottom.
text	Text string, enclosed in single quotes, centered on top or bottom of the barcode. The text string can contain dynamic values listed in “ T — Text Records ” on page 180.
atr	An attribute number, referencing an attribute from the feature attribute names section. See “ @ and & — Feature Attribute Lookup Table ” on page 174.
value	An attribute value that depends on the type of attribute: <ul style="list-style-type: none"> • BOOLEAN — No value is necessary. If the index of the attribute is listed, the attribute is set to TRUE. • FLOAT or INTEGER — A number. • OPTION — An option number. • TEXT — A number referencing the feature attribute text strings section. See “@ and & — Feature Attribute Lookup Table” on page 174.
ID=<id>	Assigns a unique identifier to the feature. See “ Unique ID ” on page 30.

Example of a Barcode Record in the Features File

```

UNITS=INCH
#
#Feature attribute names
#
@0 .nomenclature
#
#Layer features
#
B -1.73493967 0.25060236 UPC39 standard P 8 0 E 0.008 0.2 Y N Y Y T
'Barcode 1234567890';0

```

S — Surface Records

A surface definition must have at least one polygon defined. The surface usually consists of multiple records.

This is the format of the surface definition:

```

S <polarity> <dcode>;<atr>=<value>,...;ID=<id>
  <polygon 1>
  <polygon n>
SE

```

The S line is followed by polygon definitions. Each polygon is a collection of segments (lines without width) and curves (arcs without width). The polygons must meet the restrictions described in “[Surfaces](#)” on page 38.

It is recommended that each polygon be represented as a single island, because a multi-island polygon is electrically disconnected. As a single feature, it should be connected to a single net.

A polygon begins with an OB command, contains OS (segment) or OC (arc) commands, and ends with an OE command:

```
OB <xbs> <ybs> <poly_type>
  OS <x> <y>
  ...
  OC <xe> <ye> <xc> <yc> <cw>
  ...
OE
```

The last OS or OC coordinate should be the same as the OB coordinate.

S Records

These are the parameters for the S line:

S Parameter	Explanation
polarity	P — Positive. N — Negative.
dcode	Gerber dcode number or Excellon tool number (0 if not defined).
atr	An attribute number, referencing an attribute from the feature attribute names section of the lookup table. See “ @ and & — Feature Attribute Lookup Table ” on page 174.
value	An attribute value that depends on the type of attribute: <ul style="list-style-type: none"> • BOOLEAN — No value is necessary. If the index of the attribute is listed, the attribute is set to TRUE. • FLOAT or INTEGER — A number. • OPTION — An option number. • TEXT — A number referencing the feature attribute text strings section of the lookup table. See “@ and & — Feature Attribute Lookup Table” on page 174.
ID=<id>	Assigns a unique identifier to the feature. See “ Unique ID ” on page 30.

OB Records

These are the parameters of the OB (begin) line:

OB Parameter	Explanation
xbs, ybs	Beginning point of the polygon.
poly_type	I for island, H for hole.

OS Records

These are the parameters of the OS (segment) lines:

OS Parameter	Explanation
x, y	Segment end point. The previous polygon point is the start point.
cw	Y for clockwise, N for counter-clockwise.

OC Records

These are the parameters of the OC (arc) lines:

OC Parameter	Explanation
xe, ye	Curve end point. The previous polygon point is the start point.
xc, yc	Curve center point.
cw	Y for clockwise, N for counter-clockwise.

Example of Surface Records in the Feature File

```

S P 0
  OB 5.36 3.525 I
    OS 5.36 3.809
    OS 5.501 3.809
    OS 5.501 3.735
    OS 5.431 3.735
    OS 5.431 3.525
    OS 5.36 3.525
  OE
  OB 5.593 3.525 I
    OS 5.593 3.73
    OS 5.75 3.73
    OS 5.75 3.525
    OS 5.593 3.525
  OE
SE

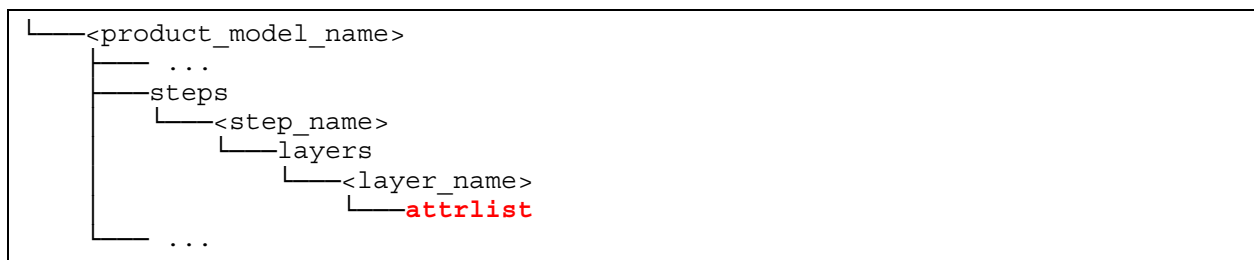
```

<layer_name>/notes (Electronic Notes)

The *notes* file contains notes added by the user.

notes (Electronic Notes)	
Type	Line Record Text
Compression	None
Path	<product_model_name>/steps/<step_name>/layers/<layer_name>/notes
UNITS	The UNITS directive is not relevant for the <i>notes</i> file.

This file contains all the notes added by the user to the graphic layer.



Example of a notes file

```
866467418,moshik,2.03807,-1.22818,,,,,First line\nSecond line
```

Each line in the notes file has this format:

```
<time>,<user>,<x>,<y>,,,,,<note>
```

Field	Explanation
time	Last date updated. Uses a standard UNIX time code method that is the number of seconds that have passed since January 1st, 1970.
user	User who most recently updated the note.
x, y	Graphic location expressed in accordance with UNITS=MM INCH.
note	Up to four lines of text where the \n character describes the line break

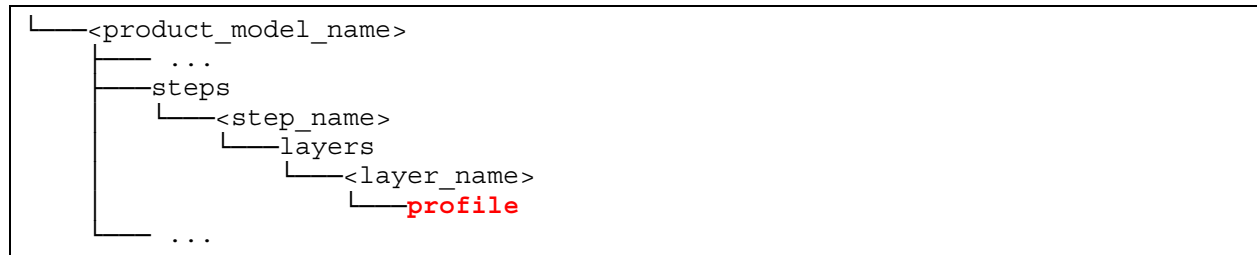
<layer_name>/profile (Outline Shape of Layer)

The layer profile is defined as a multi-island contour according to ODB++ contour definition.

See “[Geometric Entities](#)” on page 39. Every island can contain several holes. The island must completely surround its holes, and the holes must not touch one another or intersect within the island. No other features are considered legal for the layer profile.

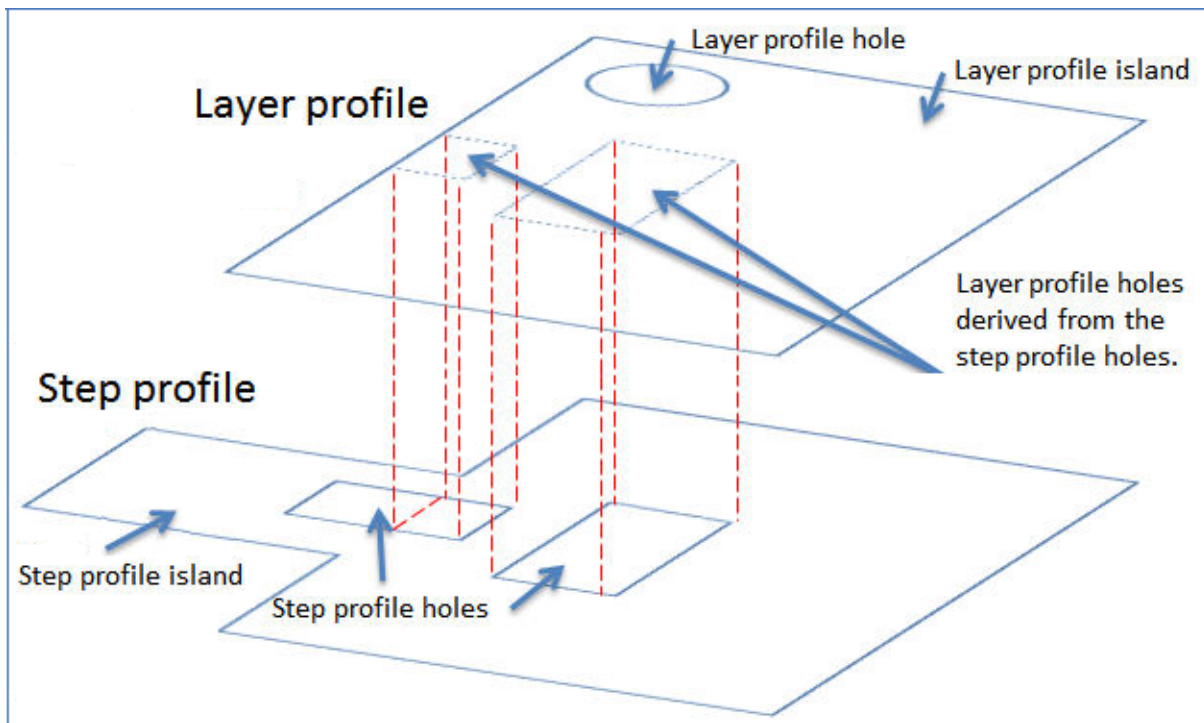
profile	
Type	Line Record Text
Compression	Yes
Path	<i><product_model_name>/steps/<step_name>/layers/<layer_name>/profile</i>
UNITS	The UNITS directive is required.

The layer profile is optional. A layer can contain one profile or no profile. The layer profile contains information relating to a single layer profile—the outline of the layer profile and its related attributes. All are optional.



The layer profile is primarily used for rigid-flex boards, where the rigid and flex parts of the board might have different physical limits. A layer profile is used to define these physical limits.

If a step profile hole is found within a layer profile island or if it intersects a layer profile island, the step profile hole is considered to exist along with the layer profile holes. It is not necessary to create the step profile holes in the layer profile. If the step profile hole intersects the layer profile island, the layer profile island shape—with the overlapping hole area of the step removed—defines a reduced layer island polygon shape that becomes the final layer island profile shape.



If no layer profile is defined, the layer profile is assumed to be equal to the step profile of the step in which the layer is defined. It is not necessary to define a layer profile if the step profile defines the shape of each layer. See “<step_name>/profile (Outline Shape of Step)” on page 141.

The *profile* file is a *features* file defining a single surface feature. Surface features are defined as described in “<layer_name>/features (Graphic Features)” on page 170.

Example of a Layer Profile File

```

UNITS=INCH
ID=58
#
#Num features
#
F 1
#
#Layer features
#
S P 0
OB 5.688950787402 7.475950787402 I
OS 5.688950787402 7.122049212598
OS 4.936950787402 7.122049212598
OS 4.936950787402 3.838950787402
OS 5.530950787402 3.838950787402
OS 5.530950787402 3.759950787402
OS 5.786950787402 3.759950787402
OS 5.786950787402 2.303049212598
OS 5.668950787402 2.303049212598
OS 5.668950787402 0.885950787402
OS 5.786950787402 0.885950787402
OS 5.786950787402 -0.290950787402
OS 4.566950787402 -0.290950787402
OS 4.566950787402 -0.554950787402
OS 4.173049212598 -0.554950787402
OS 4.173049212598 -0.290950787402
OS 1.731950787402 -0.290950787402
OS 1.731950787402 -0.633950787402
OS -0.542950787402 -0.633950787402
OS -0.542950787402 2.456950787402
OS 0.957049212598 2.456950787402
OS 0.957049212598 2.834950787402
OS 1.035049212598 2.834950787402
OS 1.035049212598 3.898049212598
OS 0.957049212598 3.898049212598
OS 0.957049212598 5.511950787402
OS 1.035049212598 5.511950787402
OS 1.035049212598 5.984049212598
OS 0.957049212598 5.984049212598
OS 0.957049212598 6.311049212598
OS -1.113950787402 6.311049212598
OS -1.113950787402 7.475950787402
OS 5.688950787402 7.475950787402
OE
SE

```

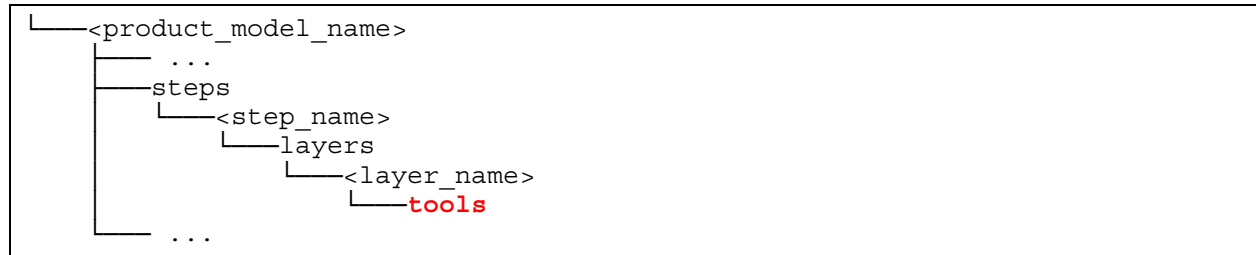
<layer_name>/tools (Drill Tools)

This file contains the tools table of a drill layer, initially created during input.

tools (Drill Tools)	
Type	Structured Text

tools (Drill Tools)	
Compression	None
Path	<i><product_model_name>/steps/<step_name>/layers/<layer_name>/tools</i>
UNITS	The UNITS directive is required.

The file contains global parameters and a **TOOLS** array structure.



Global Parameters for Drill Tools

These are the global parameters.

Field	Explanation
THICKNESS	Board thickness (mils or mm) (Obsolete). Where it is necessary to describe board thickness, it is derived from the step attribute .board_thickness. See “ ODB++ System Attributes - Alphabetical List ” on page 215.
USER_PARAMS	Free text.

Tools array structure

This is the tools array structure.

Field	Explanation
NUM	Tool number.
TYPE	One of these values: PLATED, NON_PLATED, VIA.
TYPE2	Legal values depend on the value of TYPE: <ul style="list-style-type: none"> • TYPE=PLATED — STANDARD or PRESS_FIT • TYPE=NON_PLATED — STANDARD • TYPE=VIA — STANDARD, PHOTO, or LASER (Default=STANDARD).
MIN_TOL, MAX_TOL	Allowed tolerances (mils or microns).
BIT	Drill bit string.

Field	Explanation
FINISH_SIZE	Required drill size in the finished board. (mils or microns). If this value was not set, the value should be -1.
DRILL_SIZE	Drill tool size used by the drilling machine to achieve the required finished hole size after production of the board (mils or microns) (optional).

Example of a tools file

```

UNITS=INCH
THICKNESS=62.5
USER_PARAMS=method25
TOOLS {
    NUM=1
    TYPE=VIA
    TYPE2=STANDARD
    MIN_TOL=0
    MAX_TOL=0
    BIT=
    FINISH_SIZE=11.5
    DRILL_SIZE=13.5
}
TOOLS
{
    NUM=2
    TYPE=PLATED
    TYPE2=STANDARD
    MIN_TOL=0
    MAX_TOL=0
    BIT=
    FINISH_SIZE=15
    DRILL_SIZE=19
}

```


Appendix A

Standard ODB++ Symbols

A symbol is one of the geometric primitives supported by ODB++ described here, or a combination of them. They are defined by the parameters: width, height, radius, diameter, spokes, gap, angle, size and corner. The corners of rounded or chamfered rectangles or thermals are specified in ascending order—moving counter-clockwise—starting from the top-right corner.

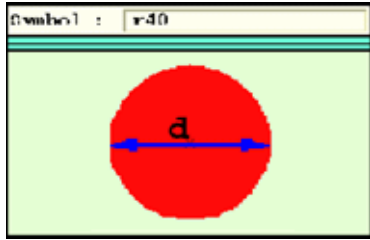
For an example of a symbol with chamfered corners, see “[Rounded/Chamfered Rectangles](#)” on page 212.

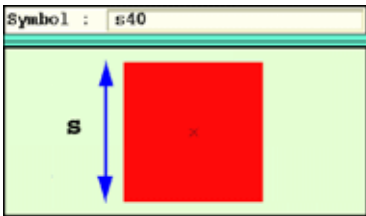
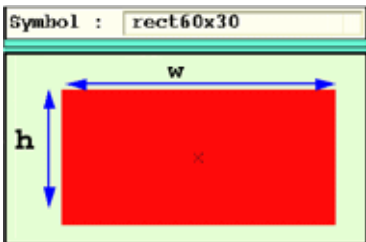
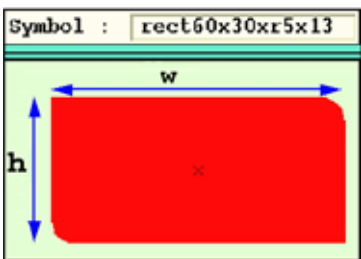

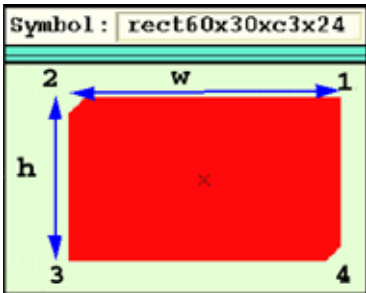

All symbols described in this section are standard (system) symbols. User defined symbols are defined as described in “[symbols \(User-Defined Symbols\)](#)” on page 94.

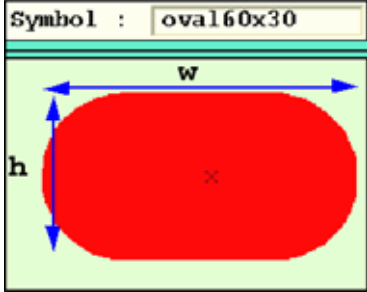
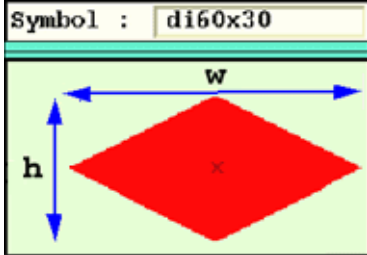
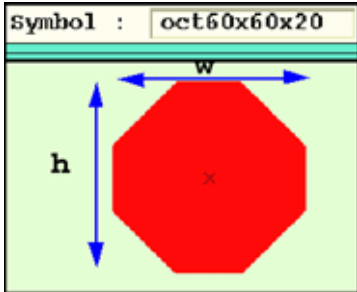
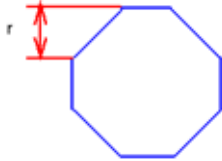
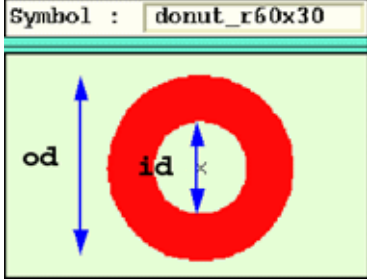
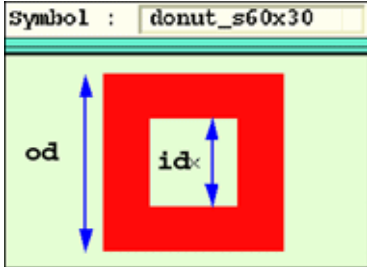
Basic Standard Symbols	195
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Other Symbol Information	212
Rotated Standard Symbols	212
Rounded/Chamfered Rectangles	212
Corner Size	213
Obsolete Symbols	213

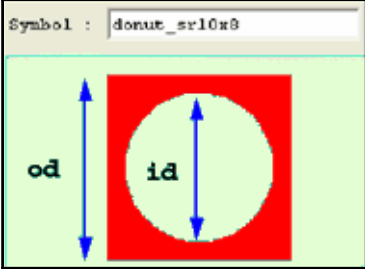
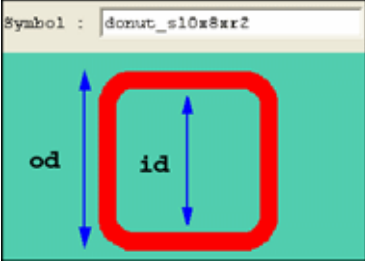

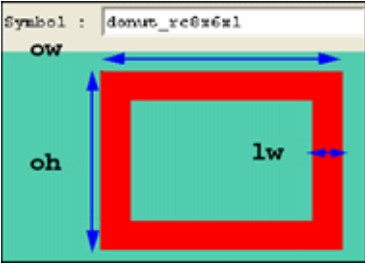
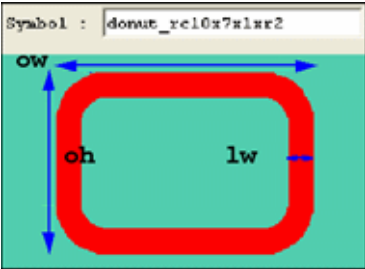

Basic Standard Symbols

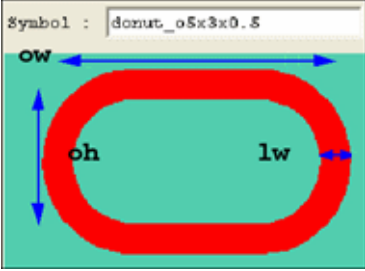
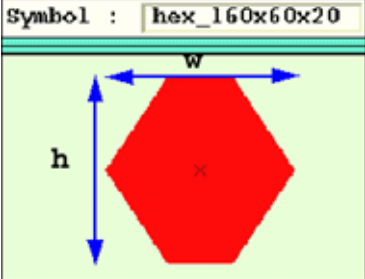
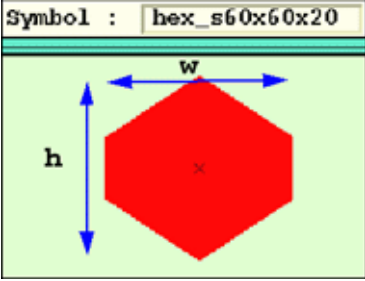
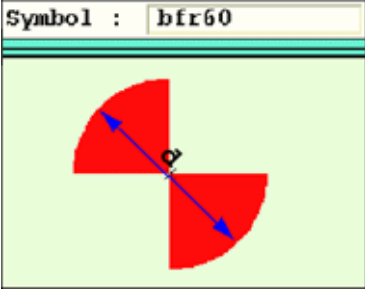
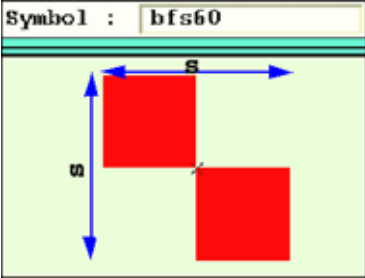
These are the basic standard symbols.

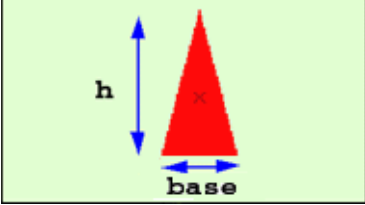

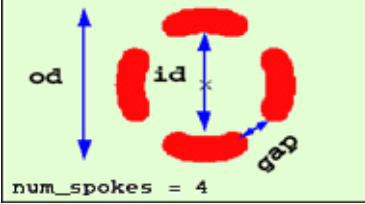
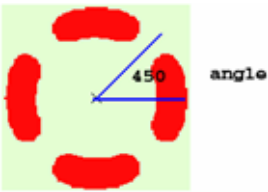
Symbol Name	Example	Parameters
Round		r<d> d — Circle diameter

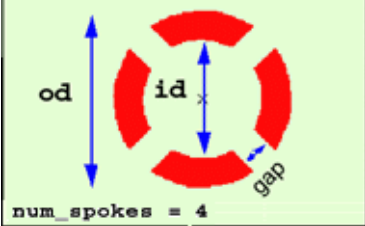
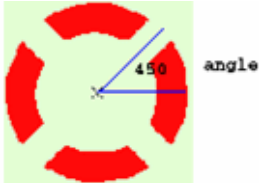
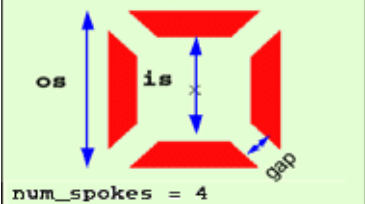
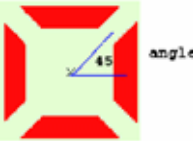
Symbol Name	Example	Parameters
Square	<p>Symbol : s40</p> 	<p>s<s></p> <p>s — Square side</p>
Rectangle	<p>Symbol : rect60x30</p> 	<p>rect<w>x<h></p> <p>w — Rectangle width</p> <p>h — Rectangle height</p>
Rounded Rectangle	<p>Symbol : rect60x30xr5x13</p> 	<p>rect<w>x<h>xr<rad>x<corners></p> <p>w — Rectangle width</p> <p>h — Rectangle height</p> <p>rad — Corner radius</p> <p>corners — Indicates which corners are rounded. x<corners> is omitted if all corners are</p> <p>rounded.</p>  <p>See “Rounded/Chamfered Rectangles” on page 212.</p>
Chamfered Rectangle	<p>Symbol : rect60x30xc3x24</p> 	<p>rect<w>x<h>xc<rad>x<corners></p> <p>w — Rectangle width</p> <p>h — Rectangle height</p> <p>rad — Corner radius</p> <p>corners — Indicates which corners are chamfered. x<corners> is omitted if all corners are</p> <p>chamfered.</p>  <p>See “Rounded/Chamfered Rectangles” on page 212.</p>

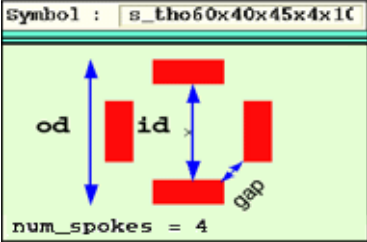
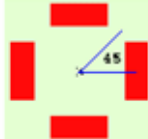
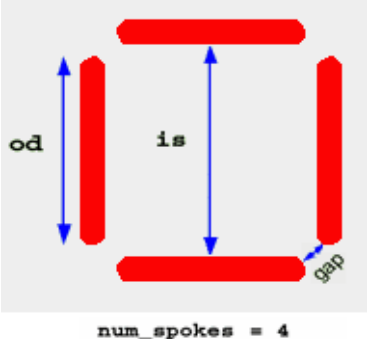
Symbol Name	Example	Parameters
Oval		oval<w>x<h> w — Oval width h — Oval height
Diamond		di<w>x<h> w — Diamond width h — Diamond height
Octagon		oct<w>x<h>x<r> w — Octagon width h — Octagon height  r — Corner size
Round Donut		donut_r<od>x<id> od — Outer diameter id — Inner diameter
Square Donut		donut_s<od>x<id> od — Outer diameter id — Inner diameter

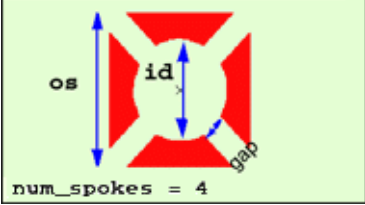
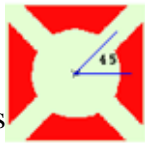
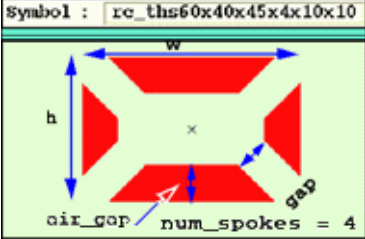
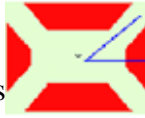
Symbol Name	Example	Parameters
Square / Round Donut		<p>donut_sr<od>x<id> od — Outer diameter id — Inner diameter</p>
Rounded Square Donut		<p>donut_s<od>x<id>xr<rad>x<corners> od — Outer diameter id — Inner diameter rad — Corner radius corners — Indicates which corners are rounded. x<corners> is omitted if all corners are rounded.</p> 
Rectangle Donut		<p>donut_rc<ow>x<oh>x<lw> ow — Outer width oh — Outer height lw — Line width</p>
Rounded Rectangle Donut		<p>donut_rc<ow>x<oh>x<lw>xr<rad>x<corners> ow — Outer width oh — Outer height lw — Line width rad — Corner radius corners — Indicates which corners are rounded. x<corners> is omitted if all corners are rounded.</p> 

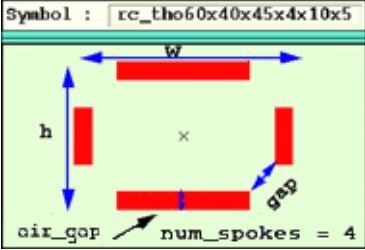
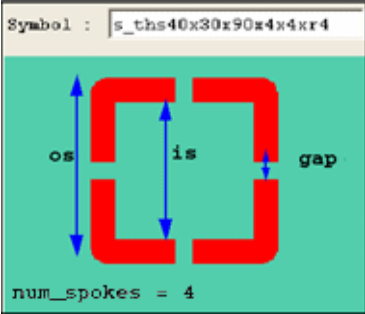
Symbol Name	Example	Parameters
Oval Donut		donut_o<ow>x<oh>x<lw> ow — Outer width oh — Outer height lw — Line width
Horizontal Hexagon		hex_l<w>x<h>x<r> w — Hexagon width h — Hexagon height r — Corner size
Vertical Hexagon		hex_s<w>x<h>x<r> w — Hexagon width h — Hexagon height r — Corner size
Butterfly		bfr<d> d — Diameter
Square Butterfly		bfs<s> s — Size

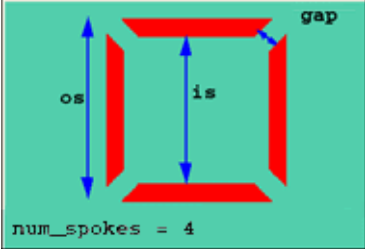
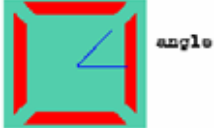

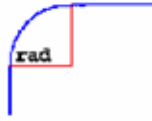
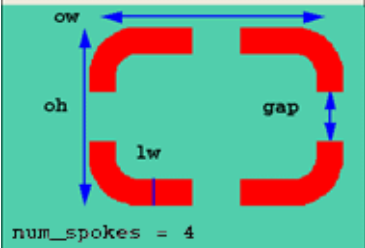


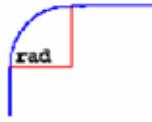
Symbol Name	Example	Parameters
Triangle	<p>Symbol : tri30x60</p> 	<p>tri<base>x<h> base — Triangle base h — Triangle height</p>
Half Oval	<p>Symbol : oval_h60x30</p> 	<p>oval_h<w>x<h> w — Width h — Height</p>
Round Thermal (Rounded)	<p>Symbol : thr60x40x45x4x10</p> 	<p>thr<od>x<id>x<angle>x<num_spokes>x<gap> od — Outer diameter id — Inner diameter angle — Gap angle from 0  degrees num_spokes — Number of spokes gap — Size of spoke gap od and id control the air gap (size of laminate separation).</p>


Symbol Name	Example	Parameters
Round Thermal (Squared)	<p>Symbol : <code>ths60x40x45x4x10</code></p> 	<p><code>ths<od>x<id>x<angle>x<num_spokes>x<gap></code></p> <p>od — Outer diameter</p> <p>id — Inner diameter</p> <p>angle — Gap angle from 0</p>  <p>num_spokes — Number of spokes</p> <p>gap — Size of spoke gap</p> <p>od and id control the air gap (size of laminate separation).</p>
Square Thermal	<p>Symbol : <code>s_ths60x40x45x4x10</code></p> 	<p><code>s_ths<os>x<is>x<angle>x<num_spokes>x<gap></code></p> <p>os — Outer size</p> <p>is — Inner size</p> <p>angle — Gap angle from 0</p>  <p>num_spokes — Number of spokes</p> <p>gap — Size of spoke gap</p> <p>os and is control the air gap (size of laminate separation).</p>

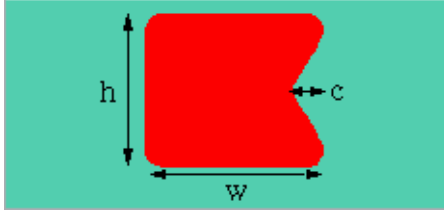
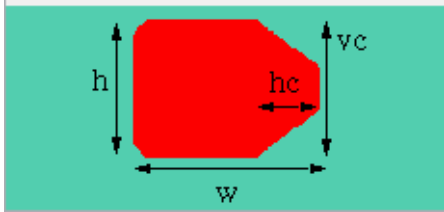
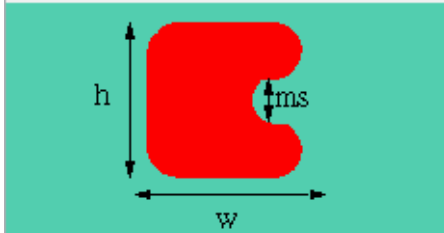
Symbol Name	Example	Parameters
Square Thermal (Open Corners)		<p>s_tho<od>x<id>x<angle>x<num_spokes>x<gap></p> <p>od — Outer diameter</p> <p>id — Inner diameter</p> <p>angle — Gap angle from 0 degrees in increments of 45</p>  <p>degrees</p> <p>num_spokes — Number of spokes: 1, 2, or 4</p> <p>gap — Size of spoke gap</p> <p>od and id control the air gap (size of laminate separation).</p>
Line Thermal		<p>s_thr<os>x<is>x<angle>x<num_spokes>x<gap></p> <p>os — Outer size</p> <p>is — Inner size</p> <p>angle — Gap angle always 45 degrees</p> <p>num_spoke — number of spokes always 4</p> <p>gap — Size of spoke gap</p> <p>Ends of lines are rounded with diameter (os-is)/2.</p>

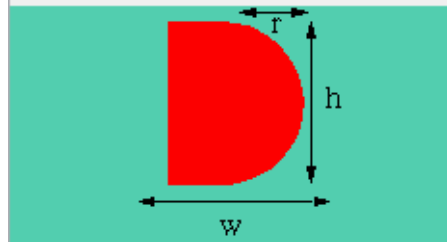
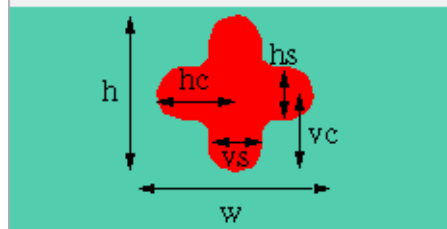







Symbol Name	Example	Parameters
Square-Round Thermal	<p>Symbol : <code>sr_ths60x40x45x4x10</code></p> 	<p><code>sr_ths<os>x<id>x<angle>x<num_spokes>x<gap></code></p> <p>os — Outer size</p> <p>id — Inner diameter</p> <p>angle — Gap angle from 0</p>  <p>degrees</p> <p>num_spokes — Number of spokes</p> <p>gap — Size of spoke gap</p> <p>os and id control the air gap (size of laminate separation).</p>
Rectangular Thermal	<p>Symbol : <code>rc_ths60x40x45x4x10x10</code></p> 	<p><code>rc_ths<w>x<h>x<angle>x<num_spokes>x<gap>x<air_gap></code></p> <p>w — Outer width</p> <p>h — Outer height</p> <p>angle — Gap angle from 0 degrees; in multiples of 45</p>  <p>degrees</p> <p>num_spokes — Number of spokes</p> <p>gap — Size of spoke gap</p> <p>air_gap — Size of laminate separation</p>

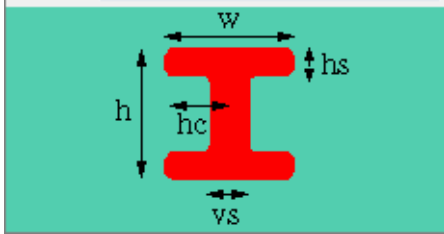

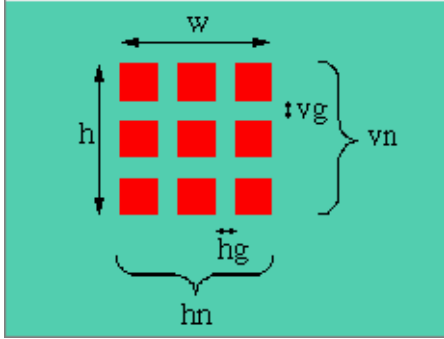
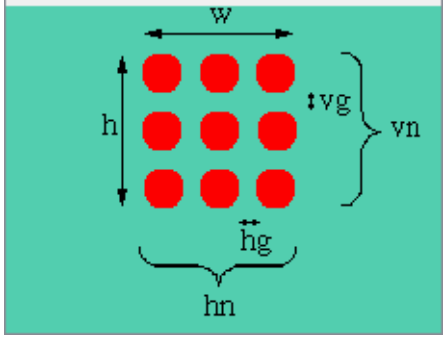
Symbol Name	Example	Parameters
Rectangular Thermal (Open Corners)	<p>Symbol : <code>rc_tho60x40x45x4x10x5</code></p> 	<p>rc_tho<w>x<h>x<angle>x<num_spokes>x<gap>x<air_gap></p> <p>w — Outer width</p> <p>h — Outer height</p> <p>angle — Gap angle from 0 degrees in multiples of 45 degrees.</p> <p>num_spokes — Number of spokes</p> <p>gap — Size of spoke gap</p> <p>air gap — Size of laminate separation</p>
Rounded Square Thermal	<p>Symbol : <code>s_ths40x30x90x4x4xr4</code></p> 	<p>s_ths<os>x<is>x<angle>x<num_spokes>x<gap>x<rad>x<corners></p> <p>os — Outer size</p> <p>is — Inner size</p> <p>angle — Gap angle from 0 degrees</p> <p>num_spokes — Number of spokes</p> <p>gap — Size of spoke gap</p> <p>rad — Corner radius</p> <p>corners — Indicates which corners are rounded. x<corners> is omitted if all corners are rounded.</p>

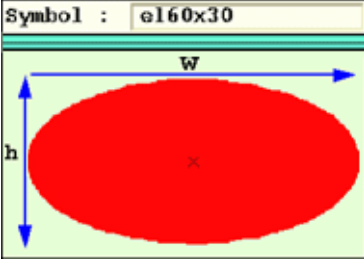
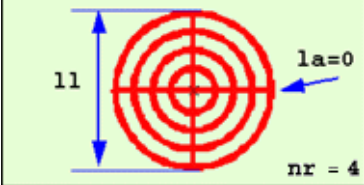
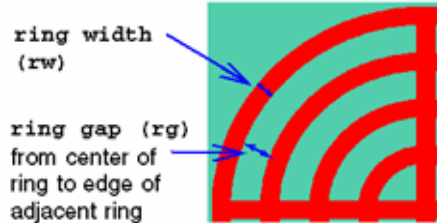
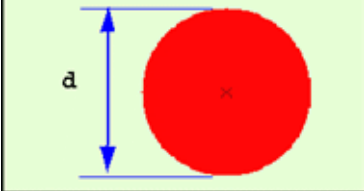
Symbol Name	Example	Parameters
Rounded Square Thermal (Open Corners)	<p>Symbol : <code>s_ths55x45x45x4x7</code></p> 	<p><code>s_ths<os>x<is>x<angle>x<num_spokes>x<gap>xr<rad>x<corners></code></p> <p>os — Outer size</p> <p>is — Inner size</p> <p>angle — Gap angle from 45 degrees</p>  <p>num_spokes — Number of spokes</p> <p>gap — Size of spoke gap</p> <p>rad — Corner radius</p> <p>corners — Indicates which corners are rounded. <code>x<corners></code> is omitted if all corners are rounded.</p>  
Rounded Rectangle Thermal	<p>Symbol : <code>rc_ths10x7x90x4x2x1xr2</code></p> 	<p><code>rc_ths<ow>x<oh>x<angle>x<num_spokes>x<gap>x<lw>xr<rad>x<corners></code></p> <p>ow — Outer width</p> <p>oh — Outer height</p> <p>lw — Line width</p> <p>angle — Gap angle from 0 degrees</p>  <p>num_spokes — Number of spokes</p> <p>gap — Size of spoke gap</p> <p>rad — Corner radius</p> <p>corners — Indicates which corners are rounded. <code>x<corners></code> is omitted if all corners are rounded.</p>  

Symbol Name	Example	Parameters
Oval Thermal		<p>o_ths<ow>x<oh>x<angle>x<num_spokes>x<gap>x<lw></p> <p>ow — Outer width oh — Outer height angle — Gap angle from 0 degrees  num_spokes — Number of spokes gap — Size of spoke gap lw — Line width</p>
Oblong Thermal		<p>oblong_ths<ow>x<oh>x<angle>x<num_spokes>x<gap>x<lw>x<r s></p> <p>ow — Outer width oh — Outer height angle — For 2 spokes, angle can be 0 or 90 degrees; for 4 spokes, angle can be 0, 45, or 90 degrees. num_spokes — Number of spokes gap — Size of spoke gap lw — Line width r s — Support for rounded or straight corners</p>
Home Plate (hplate)		<p>hplate<w>x<h>x<c> hplate<w>x<h>x<c>x<ra>x<ro></p> <p>w — Horizontal side h — Vertical side c — Cut size ($c \leq w$) ra — Corner radius (acute angle) (optional) ro — Corner radius (obtuse angle) (optional) ra and ro must meet the restrictions in “Symbols Suitable for Solder Stencil Design” on page 210.</p>

Symbol Name	Example	Parameters
Inverted Home Plate (rhplate)	<p>Symbol1: rhplate2.5x2x0.6xra0.2xro0.2</p> 	<p>rhplate<w>x<h>x<c> rhplate<w>x<h>x<c>x<ra>x<ro> w — Horizontal side h — Vertical side c — Cut size ($c < w$) ra — Corner radius (acute angle) (optional) ro — Corner radius (obtuse angle) (optional) ra and ro must meet the restrictions in “Symbols Suitable for Solder Stencil Design” on page 210.</p>
Flat Home Plate (fhplate)	<p>Symbol1: fhplate2x1.5x0.7x0.5xra0.2xro0.1</p> 	<p>fhplate<w>x<h>x<vc>x<hc> fhplate<w>x<h>x<vc>x<hc>x<ra>x<ro> w — Horizontal side h — Vertical side hc — Horizontal cut size ($hc < w$) vc — Vertical cut size ($vc < h/2$) ra — Corner radius (acute angle) (optional) ro — Corner radius (obtuse angle) (optional) ra and ro must meet the restrictions in “Symbols Suitable for Solder Stencil Design” on page 210.</p>
Radiused Inverted Home Plate (radhplate)	<p>Symbol1: radhplate0.5x0.5x0.15xra0.1</p> 	<p>radhplate<w>x<h>x<ms> radhplate<w>x<h>x<ms>x<ra> w — Horizontal side h — Vertical side ($h > (ms + (w - ms)/2)/2$) ms — Middle curve size ($ms < w$) ra — Corner radius (optional) ra and ro must meet the restrictions in “Symbols Suitable for Solder Stencil Design” on page 210.</p>

Symbol Name	Example	Parameters				
Radiused Home Plate (dshape)	<div>Symbol : dshape2x3x1xra0.003</div> 	dshape <w>x<h>x<r> dshape <w>x<h>x<r>x<ra> w — Horizontal side h — Vertical side r — Relief ($r \leq w$ or ($r = w$ and $h = 2 * w$)) ra — Corner radius (optional) ra and ro must meet the restrictions in “ Symbols Suitable for Solder Stencil Design ” on page 210.				
Cross (crossx[r s])	<div>Symbol: cross3x3x1x1x50x50xra0.3</div>  <p>Variations:</p>  <p>If the cross point is located outside the skeleton of the segment, the resulting indentation is ignored.</p> <table><tr><td>The symbol is created like this</td><td>Not like this</td></tr><tr><td></td><td></td></tr></table>	The symbol is created like this	Not like this			<p>The cross symbol consists of two intersecting orthogonal line segments. The cross point is at the intersection of their respective skeletons.</p> cross <w>x<h>x<hs>x<vs>x<hc>x<vc>x[r s] cross <w>x<h>x<hs>x<vs>x<hc>x<vc>x[r s]<ra> w — Horizontal side h — Vertical side hs — Horizontal line width ($hs < h$) vs — Vertical line width ($vs < w$) hc — Horizontal cross point vc — Vertical cross point r s — Line style (round or square) ra — Inside corner radius (limited by the lengths of the line segments)
The symbol is created like this	Not like this					
						

Symbol Name	Example	Parameters
Dogbone (dogbonex[r s])	<p>Symbol: dogbone50x50x10x15x50x50x3</p>  <p>Variation: </p>	<p>dogbone<w>x<h>x<hs>x<vs>x<hc>x[r s]</p> <p>dogbone<w>x<h>x<hs>x<vs>x<hc>x[r s]x<ra></p> <p>w — Horizontal side</p> <p>h — Vertical side</p> <p>hs — Horizontal line width ($hs < h/2$)</p> <p>vs — Vertical line width ($vs < h$)</p> <p>hc — Horizontal cross point</p> <p>r s — Line style (round/square)</p> <p>ra — Corner radius (must be less than the whichever value is smaller: hs or $vs/2$)</p>
D-Pack (dpack)	<p>Symbol: dpack100x100x15x15x3x3</p>  <p>Symbol: dpack100x100x15x15x3x3xra1</p> 	<p>The individual pads of dpack can be straight or rounded, depending on the corner radius (ra) parameter.</p> <p>dpack<w>x<h>x<hg>x<vg>x<hn>x<vn></p> <p>dpack<w>x<h>x<hg>x<vg>x<hn>x<<vn>x<ra></p> <p>w — Horizontal side</p> <p>h — Vertical side</p> <p>hg — Horizontal gap ($hg < h$)</p> <p>vg — Vertical gap ($vg < v$)</p> <p>vn — Columns number</p> <p>hn — Rows number</p> <p>ra — Corner radius ($ra \leq [\text{the smaller of } hs \text{ and } vs]/2$)</p> <p>The horizontal and vertical sides of an individual pad within the D-Pack are calculated. They are not user-defined. They must be greater than zero.</p> <ul style="list-style-type: none"> $hs = w - hg \cdot (hn - 1) / hn$ $vs = h - (vg \cdot (vn - 1)) / vn$

Symbol Name	Example	Parameters
Ellipse	<p>Symbol : <code>el160x30</code></p> 	<p><code>el</code><<i>w</i>><i>x</i><<i>h</i>> <i>w</i> — Width <i>h</i> — Height</p>
Moire	<p>Symbol : <code>moire5x10x4x4x100x0</code></p>  	<p><code>moire</code><<i>rw</i>><i>x</i><<i>rg</i>><i>x</i><<i>nr</i>><i>x</i><<i>lw</i>><i>x</i><<i>ll</i>> <i>x</i><<i>la</i>> <i>rw</i> — Ring width <i>rg</i> — Ring gap <i>nr</i> — Number of rings <i>lw</i> — Line width <i>ll</i> — Line length <i>la</i> — Line angle</p>
Hole	<p>Symbol : <code>hole50xpx4x5</code></p> 	<p><code>hole</code><<i>d</i>><i>x</i><<i>p</i>><i>x</i><<i>tp</i>><i>x</i><<i>tm</i>> <i>d</i> — Hole diameter <i>p</i> — Plating status (p(lated), n(on-plated) or v(ia)) <i>tp</i> — Positive tolerance <i>tm</i> — Negative tolerance Intended for wheels created for drill files.</p>
Null		<p><code>ext</code> — Extension number Used as a place holder for non-graphic features.</p>

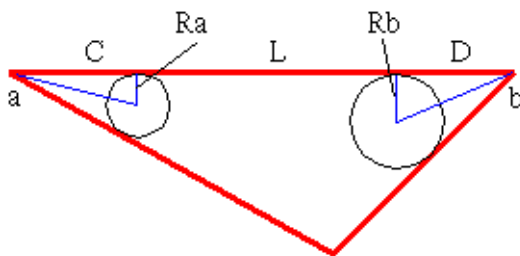
Symbols Suitable for Solder Stencil Design

Several symbols were added to fulfill the requirements for effective stencil design manufacture.

These symbols are suitable for solder stencil design:

- Home Plate (hplate)
- Inverted Home Plate (rhplate)
- Flat Home Plate (fhplate)
- Radiused Inverted Home Plate (radhplate)
- Radiused Home Plate (dshape)
- Cross (cross...[r|s])
- Dogbone (dogbone...r|s)
- D-Pack (dpack)

Most of these symbols can be created with either straight or rounded corners. If you specify a corner radius to be used for rounding the symbol, corners can be rounded only if the rounded part of one corner would not meet the rounded part of an adjacent corner.



The diagram shows how two corners of a symbol are to be rounded:

Ra — Perpendicular radius of corner a.

Rb — Perpendicular radius of corner b.

C — Distance from perpendicular radius to corner a.

D — Distance from perpendicular radius to corner b.

L — Length of the side connecting the two corners.

Aa, Ab — Angles at corners a and b.

If $L > C + D$, the symbol can be created with rounded corners.

This restriction can be expressed as: $L > Ra/\tan(Aa/2) + Rb/\tan(Ab/2)$.

Other Symbol Information

Symbol topics are discussed.

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Rotated Standard Symbols

Prior to ODB++ version 7.0, pads and text could be rotated only in increments of 90 degrees. Angles other than 0, 90, 180 or 270 were considered user-defined symbols; and that increased the amount of feature data stored in the product model.

Rotation of pads and text at any angle is now allowed.

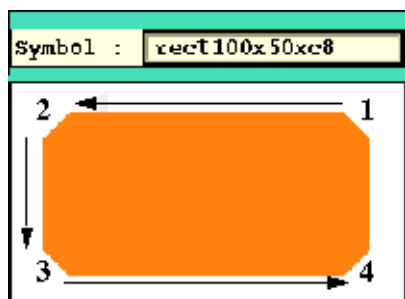
Note



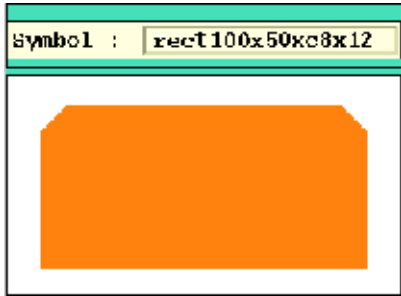
Rotation is clockwise.

Rounded/Chamfered Rectangles

The corners of rounded/chamfered rectangles are specified in ascending order counter-clockwise, starting from the top-right corner. If all corners are to be rounded/chamfered, there is no need to specify corners after the corner radius parameter. A rectangle with all corners chamfered is indicated by: `rect100x50xc8`—100=width, 50=height, 8=corner radius.



A rectangle with only the top right corner chamfered is indicated by: `rect100x50xc8x12` (12 indicates top right and top left corners).



These are the standard symbols whose corners can be rounded or chamfered:

- Rounded Rectangle
- Chamfered Rectangle
- Rounded Square Donut
- Rounded Rectangle Donut
- Rounded Square Thermal
- Rounded Square Thermal (Open Corners)
- Rounded Rectangle Thermal

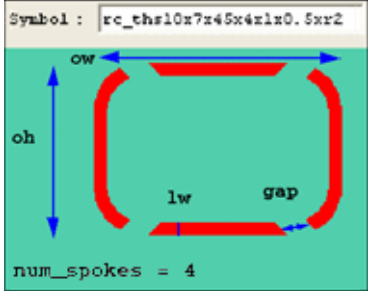
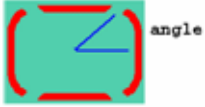

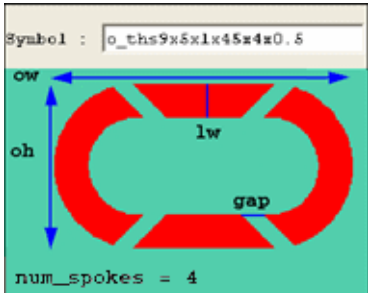

Corner Size

The standard Octagon symbol corner size is the distance between the bounding box corner and the vertex.



Obsolete Symbols

These symbols are obsolete.

Symbol Name	Example	Parameters
Rounded Rectangle Thermal (Open Corners)	<p>Symbol : rc_ths10x7x45x4x1x0.5x2</p> 	<p>rc_ths<ow>x<oh>x<angle>x<num_spokes>x<gap>x<lw>x<rad>x<corners>></p> <p>ow — Outer width oh — Outer height lw — Line width angle — Gap angle of 45 degrees  num_spokes — Number of spokes gap — Size of spoke gap rad — Corner radius corners — Indicates which corners are rounded. x<corners> is omitted if all corners are rounded.  </p>
Oval Thermal (Open Corners)	<p>Symbol : o_ths9x5x1x45x4x0.5</p> 	<p>o_ths<ow>x<oh>x<angle>x<num_spokes>x<gap>x<lw></p> <p>ow — Outer width oh — Outer height angle — Gap angle of 45 degrees  num_spokes — Number of spokes gap — Size of spoke gap lw — Line width</p>

Appendix B

System Attributes

Attributes are user-defined properties that add intelligence to the ODB++ data and facilitate automation.

See “[ODB++ Attributes](#)” on page 27.

All measurable values are interpreted according to the UNITS directive in the corresponding attribute definition file. See “[Units of Measurement](#)” on page 23.

For information on the *sysattr* file to which each attribute belongs, see “[ODB++ System Attributes by Class](#)” on page 271.

For an attribute that requires a units of measurement definition, this is indicated in the description. Attributes without a units of measurement definition are expressed using the units of measurement of the product model.

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Product (sysattr)	271
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Fabrication (sysattr.fab)	279
Assembly (sysattr.assy)	281
Test (sysattr.test)	283
Generic (sysattr.gen)	284

ODB++ System Attributes - Alphabetical List

These are the system attributes.

Attribute	Type	Entity	Description	Display Name
.all_eda_layers	Text	Step	(0 to 1000 characters) This attribute consists of a list of all the layers in the current EDA design (not ODB++).	All EDA Layers
.allowed_to_remove_non_functional_pads	Boolean	Step	Indicates whether it is allowed to remove nonfunctional pads.	Allowed to Remove nonfunctional Pads

Attribute	Type	Entity	Description	Display Name
.aoi_cpbm	Integer	Feature	(0 to 255) (Obsolete)	.aoi_cpbm
.aoi_cpcu	Integer	Feature	(0 to 255) (Obsolete)	.aoi_cpcu
.aoi_drbm	Integer	Feature	(0 to 255) (Obsolete)	.aoi_drbm
.aoi_drcu	Integer	Feature	(0 to 255) (Obsolete)	.aoi_drcu
.aoi_value	Integer	Feature	(0 to 255) (Obsolete)	.aoi_value
.ar_pad_drill_bottom_max	Float	Feature	(-10 to 1000) Assigned to a drill to define the maximum annular ring size between the drill and the copper of the bottom layer of the drill span. (UNITS=MIL_MICRON)	Max Pad AR Drill Bottom
.ar_pad_drill_bottom_min	Float	Feature	(-10 to 1000) Assigned to a drill to define the minimum annular ring size between the drill and the copper of the bottom layer of the drill span. (UNITS=MIL_MICRON)	Min Pad AR Drill Bottom
.ar_pad_drill_inner_max	Float	Feature	(-10 to 1000) Assigned to a drill to define the maximum annular ring size between the drill and the copper of an inner layer in the drill span. (UNITS=MIL_MICRON)	Max Pad AR Drill Inner
.ar_pad_drill_inner_min	Float	Feature	(-10 to 1000) Assigned to a drill to define the minimum annular ring size between the drill and the copper of an inner layer in the drill span. (UNITS=MIL_MICRON)	Min Pad AR Drill Inner

Attribute	Type	Entity	Description	Display Name
.ar_pad_drill_top_max	Float	Feature	(-10 to 1000) Assigned to a drill to define the maximum annular ring size between the drill and the copper of the top layer of the drill span. (UNITS=MIL_MICRON)	Max Pad AR Drill Top
.ar_pad_drill_top_min	Float	Feature	(-10 to 1000) Assigned to a drill to define the minimum annular ring size between the drill and the copper of the top layer of the drill span. (UNITS=MIL_MICRON)	Min Pad AR Drill Top
.ar_sm_drill_bottom_max	Float	Feature	(-10 to 1000) Assigned to a drill piercing the bottom layer, to define the maximum annular ring size between the drill and the soldermask on the bottom layer. (UNITS=MIL_MICRON)	Max SM AR Drill Bottom
.ar_sm_drill_bottom_min	Float	Feature	(-10 to 1000) Assigned to a drill piercing the bottom layer, to define the minimum annular ring size between the drill and the soldermask on the bottom layer. (UNITS=MIL_MICRON)	Min SM AR Drill Bottom
.ar_sm_drill_top_max	Float	Feature	(-10 to 1000) Assigned to a drill piercing the top layer, to define the maximum annular ring size between the drill and the soldermask on the top layer. (UNITS=MIL_MICRON)	Max SM AR Drill Top

Attribute	Type	Entity	Description	Display Name
.ar_sm_drill_top_min	Float	Feature	(-10 to 1000) Assigned to a drill piercing the top layer, to define the minimum annular ring size between the drill and the soldermask on the top layer. (UNITS=MIL_MICRON)	Min SM AR Drill Top
.ar_sm_pad_bottom_max	Float	Feature	(-10 to 1000) Assigned to a drill piercing the bottom layer, to define the maximum annular ring size between the drilled pad of the bottom layer and the soldermask above. (UNITS=MIL_MICRON)	Max SM AR Bottom
.ar_sm_pad_bottom_min	Float	Feature	(-10 to 1000) Assigned to a drill piercing the bottom layer, to define the minimum annular ring size between the drilled pad of the bottom layer and the soldermask above. (UNITS=MIL_MICRON)	Min SM AR Bottom
.ar_sm_pad_top_max	Float	Feature	(-10 to 1000) Assigned to a drill piercing the top layer, to define the maximum annular ring size in between the drilled pad of the top layer and the soldermask above. (UNITS=MIL_MICRON)	Max SM AR Top
.ar_sm_pad_top_min	Float	Feature	(-10 to 1000) Assigned to a drill piercing the top layer, to define the minimum annular ring size in between the drilled pad of the top layer and the solder mask above. (UNITS=MIL_MICRON)	Min SM AR Top

Attribute	Type	Entity	Description	Display Name
.area_name	Text	Feature	(0 to 64) Assigned to surface features that are drawn in a process map layer. A process map layer is used in assembly analysis for determining the process type used in the location at which a measurement is found.	DFx Area Name
.array_with_rotation	Boolean	Step	(YES, NO) (default=NO) If YES, this step is a multi-panel array, with the same panel possibly appearing in 180-degree rotation to itself	Array with Rotation
.artwork	Text	Feature	(0-1000) Indicating to which entity the feature belongs (component, package, net, board)	Feature Source
.assembly_proc_bottom	Text	Step	(0 to 20) Default assembly process for the bottom side, to be used when there is no specific area defined in the process map layer (or no process map layer at all)	Assembly Process (Bottom)
.assembly_proc_top	Text	Step	(0 to 20) Default assembly process for the top side, to be used when there is no specific area defined in the process map layer (or no process map layer at all).	Assembly Process (Top)
.axi_direction	Option	Step	(Left2Right; Top2Bottom; Right2Left; Bottom2Top) Defines the angle at which a board is inserted into a 5DX machine. Values are translated as 0, 90, 180, 270 degrees.	Assembly X-Ray Inspection Direction

Attribute	Type	Entity	Description	Display Name
.backdrill_penetrate_stop_layer	Text	Layer	(0-64) Used by Backdrill Analysis to indicate the layer not to be penetrated during the backdrill process.	Backdrill not Penetrate Layer Name
.bit	Text	Feature	(0-64) Contains the drill designator that is to be used for each tool.	Drill Designator
.board_mark	Option	Feature	(bbm, gpm) In Vi-Technology output, this controls whether a step or a panel needs to be inspected: bbm —this feature is a bad board mark. Skip inspection of the step. gpm —this feature is a good panel mark. The panel can be accepted for printing without scanning its steps for bad board marks.	VI Tech. Board Mark
.board_thickness	Float	Product Model	(0.0 to 10.0; default=0.0) Total thickness of the board. (UNITS=MIL_MICRON)	Board Thickness
.bond_name	Text	Feature	Name of the wire bond.	Name of Wire Bond
.bonding_profile	Text	Feature	Name of the bonding profile.	Bonding profile

Attribute	Type	Entity	Description	Display Name
.break_away	Boolean	Symbol	(Default=NO) Assigned to a symbol that represents a break-away that can be inserted into any line or arc of the rout path. When adding a break_away symbol through dimensions, it automatically adjusts to the line or arc angle, breaks that feature (in the breaking points defined in that symbol with the .brk_pnt attribute), and adds all the necessary connections and dimensions.	Break Away
.brk_point	Boolean	Feature	(YES, NO) Assigned to a pad or a dpoint in a break-away symbol (that was given the attribute .break_away). When adding the break-away to the line/arc in the layer, through dimensions, the line/arc is broken at the connection point with the dpoint that has the .brk_point attribute. In each break-away symbol there should be two points with this attribute.	Rout Break Point
.bulk_resistivity	Float	Layer	(0-10000; Default=0) The nano-ohmic resistance of the semiconductor material. ($n\Omega \cdot m$) (UNITS=NANO_OHM)	Bulk Resistivity (nano-ohm-m)
.cad_local_footprint_change	Boolean	Comp.; Pkg.	(Default=NO) Indicates whether there has been a local change to a pad code in the local design.	CADStar Pad Change

Attribute	Type	Entity	Description	Display Name
.cad_package_name	Text	Comp.	(0-10000) Contains the full CAD package name of a Cadstar component. This name can be longer than the Valor package name which is limited to 64 characters.	CADStar Package Name
.cad_part_override	Text	Comp.; Pkg.	(0-64) Assigns component properties in accordance with data received from the ASSY_PN_OVERRIDE property.	CAD Part Variant Support
.center_fiducial	Boolean	Comp.; Pkg.	(Default=NO) Specifies component is expected to have a fiducial at its center.	Center Fiducial Required
.centroid_correction_x	float	Comp; Pkg	(-100 to 100) Specifies the x-offset from the CAD centroid to the calculated package centroid.	Centroid Correction X
.centroid_correction_y	float	Comp; Pkg	(-100 to 100) Specifies the y-offset from the CAD centroid to the calculated package centroid.	Centroid Correction Y

Attribute	Type	Entity	Description	Display Name
.color	Text	Feature; Comp.	<p>(0 to 1000 for each color) Can be attached to any feature or component to define the color to be used in plotting a layer in HPGL-1 or 2. The format is rrggbb (where r=red, g=green, b=blue).</p> <p>White—.color="999999" Black—.color="000000" Red—.color="990000" Green—.color="009900" Yellow—.color="009999" Blue—.color="000099" Magenta—.color="990099" Cyan—.color="999900"</p>	HPGL Output Color
.comment	Text	Product Model; Step; Layer; Wheel; Symbol; Buildup	<p>(0 to 500) Used for general textual comments.</p>	Comment
.comp	Option	Feature	<p>(none; right; left) For a chained feature, this attribute sets the offset of the cutting tool from the rout path. Three options:</p> <ul style="list-style-type: none"> • None—in center of the rout path • Left—to the left of the rout path in the direction of cutting • Right—to the right of the path 	Rout Compensate
.comp_height	Float	Feature; Comp.; Pkg	<p>(0.0 to 10.0) Stores the height of the component above the board surface. (UNITS=INCH_MM)</p>	Height

Attribute	Type	Entity	Description	Display Name
.comp_height_area	Integer	Feature; Comp.	(0.0 to 1000000.0; default=0) This attribute is used to assign the same ID to a component under which there is an area with space for a shorter component, and to the feature that defines the area.	Allegro Height ID
.comp_height_max	Float	Comp.; Pkg.	(0.0-10.0) The height of the tallest package (in the CPN package of alternate MPNs) above the board surface. (UNITS=INCH_MM)	Maximal Height
.comp_htol_minus	Float	Comp.; Pkg.	(0.0-10.0) Contains the minus tolerance for component height, used for calculation of plug-in boards. (UNITS=INCH_MM)	Height Tolerance Minus
.comp_htol_plus	Float	Comp.; Pkg.	(0.0-10.0) Contains the plus tolerance for component height, used for calculation of plug-in boards. (UNITS=INCH_MM)	Height Tolerance Plus
.comp_ign_spacing	Boolean	Comp.; Pkg.	(Default=NO) This attribute, when set, disables spacing checks on a component during assembly analysis. It is used for printed components that have no actual body	Ignore during Spacing Analysis
.comp_ignore	Boolean	Comp.; Pkg.	(Default=NO) Determines whether the component is to be ignored when calculating statistics, or during certain operations, such as analysis.	Ignore

Attribute	Type	Entity	Description	Display Name
.comp_mount_type	Option	Comp.; Pkg.	(Other; SMT; THMT; PressFit) Indicates whether the component is a surface mount, through-hole mount, press-fit or other. (SMT;THMT;PRESSFIT)	Mount Type
.comp_name	Text	Comp.	Name of the die component on the HDI technology layer.	Name of Die Component
.comp_polarity	Option	Comp.; Pkg.	<ul style="list-style-type: none"> • POLARIZED, has a specific pin designated as pin #1. • NON_POLARIZED has no specific pin #1. 	Polarity
.comp_type	Option	Comp.; Pkg.	<p>This attribute represents the type of the component. Options are:</p> <p>axial; bga; cbga; cob; dip; discrete; discrete402; discrete603; label; pga; pihconn; pihmisc; plcc; pqfp; printed; qfp; radial; sip; smtconn; smtmisc; socket; soic; soj; sop; sot; tab; tqfp; tsoic; tsop</p>	Type I
.comp_type2	Option	Comp.; Pkg.	<p>Options are:</p> <p>axial; axial-large; bga; cbga; cob; csp; dip; dip300; dip600; discrete; discrete201; discrete402; discrete603; electro-mech; flipchip; label; lcc; lqfp; pfconn; pga; pihconn-inline; pihconn-rt-angle; pihmisc; pih-polar; plcc; pqfp; printed; qfp; radial; radial-tall; sip; smtconn; smtelect-mech; smtmisc; smtmixedconn; smtpolar; socket; soic; soj; solderable-mech; sop-ssop; sot; tab; tqfp; tsoic; tsop; tsop-tssop</p>	Type II

Attribute	Type	Entity	Description	Display Name
.comp_variant_list	Text	Comp.; Pkg.	(0-1000) Consists of a list of variants where a component is used. The list contains variant names separated by a colon (:). See “ Component Variants ” on page 41.	Variant List
.comp_weight	Float	Comp.; Pkg.	(0.0-1000.0) Stores the weight of the component (in accordance to its Units of Measurement) for the purpose of the total weight calculation.	Weight
.copper_weight	Float	Layer	(0.0 to 1000.0; default=1.0) The weight of copper according to its Units of Measurement .	Copper Weight
.critical_net	Boolean	Feature; Net	(YES, NO) Specifies critical nets.	SQA Critical Net
.critical_tp	Boolean	Feature	(YES, NO) Assigned to the mid-point of a netlist to force it to become a testpoint. If both .non_tp and .critical_tp are assigned to the same point, .critical_tp takes precedence and the mid point is tested. In case of a drilled feature the attribute must be added to the drill hole.	Netlist Critical Midpoint Output
.cu_base	Boolean	Layer	(Default=NO) (Obsolete) Indicates whether the via holes created by a drill layer are filled (rather than plated). This attribute is only suitable for drill layers.	Vias Need Cu

Attribute	Type	Entity	Description	Display Name
.current_variant	Text	Step	(0-100) Consists of the name of the current variant for a step. See “Component Variants” on page 41.	Current Variant
.customer	Text	Product Model	(0-100) This attribute can store the name of the customer for whom the product model was created.	Customer
.cut_line	Integer	Feature	(0-100000; default=0) Assigned to lines added in the creation of film layers by the film optimization algorithm. The attribute is given to three kinds of lines: <ul style="list-style-type: none"> • frame of the film • cutting lines inside the film • frame of each layer inside the film. 	Film Optimization Cut Line
.data_source	Text	Product Model; Step	(0-100) The source of the data. For example, Cadence, Mentor.	Data Source
.desc1....10	Text	Comp.; Pkg.	(0-1000) Storage for ten BOM description fields into corresponding ten description attributes.	General Description 1....10
.design_center	Text	Product Model; Step	(0-100) The design center from which the product model originated.	Design Center
.design_origin_x	Integer	Product Model	(-254000000 to 254000000) Defines the design origin x coordinate.	Design X Origin
.design_origin_y	Integer	Product Model	(-254000000 to 254000000) Defines the design origin y coordinate.	Design Y Origin

Attribute	Type	Entity	Description	Display Name
.device_style	Text	Comp.; Pkg.	(0-64) This attribute is an enhancement of .device_type and is used to store the style of the component as defined in GenCAD (such as, NPN, PNP, NFET, PFET, NJFET, PJFET, TTL, CMOS and ECL).	Device Style
.device_type	Text	Comp.; Pkg.	(0-64) Stores the type of the component as defined in the device (such as, RES, VRES, DIODE, ZENER, LOGIC, SWITCH, CONN, etc.).	Device Type
.device_value	Text	Comp.; Pkg.	(0-64) Stores the electrical value of a component.	Device Electrical Value
.device_value_ntol	Float	Comp.; Pkg.	0-1000000; default=0.0) This is a real value expressing the percent of the value to use as a tolerance (negative tolerance). This is used for all devices. Range of characters: all floating point numbers.	Device Value Negative Tolerance
.device_value_ptol	Float	Comp.; Pkg.	(0-1000000; default=0.0) This is a real value expressing the percent of the value to use as a tolerance (positive tolerance). This is used for all devices.	Device Value Positive Tolerance
.dielectric_constant	Float	Layer	(0.0 to 1000.0; default=0.0) The ratio of the field without dielectric (E ₀) to the net field (E) with dielectric. It is unitless and has a range value of 1 for metals. Typical values are 4 and 5.	Dielectric Constant (ER)

Attribute	Type	Entity	Description	Display Name
.diff_pair	Text	Net	(0 to 64) Differential pair name associating two nets that must be routed together.	Differential Pair
.dpair_gap	Float	Net	(0.0 to 10.0) Spacing gap value specifying the spacing between differential pair nets. (UNITS=INCH_MM)	Differential Pair Spacing
.drc_add_rad	Integer	Mania_AOI	(0 to 100; default=2) (Obsolete)	Enlarge By
.drc_assembly_lyrs	Option	Feature	(Top; Bottom; Both) Specifies whether the keepout/keepin area applies to Top, Bottom, or Both component layers.	Assigned Area to Component Side
.drc_bend_keepout	Boolean	Feature	NOT USED	FLEX Bend Keepout Area
.drc_board	Boolean	Feature	(YES, NO) Assigned to a DRC area defined for the whole board.	Analysis Board Area
.drc_comp_height	Boolean	Feature	(YES, NO) Assigns component height restriction to a keepin/keepout area.	Component Height for Area
.drc_comp_height_lyr	Text	Product Model	(0 to 64) Stores name of document layer in which all component height restriction keepin/keepout areas are stored.	Comp. Height Restriction Layer
.drc_comp_keepin	Boolean	Feature	(YES, NO) Defines an area as the board's component placement keepin boundary.	Component Keep In
.drc_comp_keepin_lyr	Text	Product Model	(0 to 64) Stores name of document layer in which all component keepin areas are stored.	Component Keep In Layer

Attribute	Type	Entity	Description	Display Name
.drc_comp_keepout	Boolean	Feature	(YES, NO) Defines an area as the board's component placement keepout boundary.	Component Keep Out
.drc_comp_keepout_lyr	Text	Product Model	(0 to 64) Stores name of document layer in which all component keepout areas are stored.	Component Keep Out Layer
.drc_etch_lyrs	Text	Feature	(0 to 1000) Value=layer names separated by semi-colons (;). User-defined attribute for user to specify name of layers in which to activate keepin/keepout areas. For example, when .drc_etch_lyrs=pg1;pg2 , this enables you to select/highlight (on the relevant document layer) keepin/keepout areas that are active in layers pg1, pg2 . The attributes: .drc_etch_lyrs_bit and .drc_etch_lyrs must both specify the same layers. If there is a discrepancy between the two, then .drc_etch_lyrs_bit is the determining attribute.	DFx Area Layers by Name
.drc_etch_lyrs_all	Boolean	Feature	(YES, NO) Defines a keepin/keepout area as effective on all layers.	DFx Area All Layers

Attribute	Type	Entity	Description	Display Name
.drc_etch_lyrs_bit	Text	Feature	(0 to 64) Values=string consisting of '0' and '1' characters. Allows the keepin/keepout area to apply only to specified board layers. The attribute's length is equal to the number of board layers. 0=ignore layer, 1=activate areas in that layer	DFx Area Selected Layers
.drc_max_height	Float	Feature	(0.0 to 10.0) Stores the maximum height of components to be allowed in a height restriction area (area with .drc_comp_height attribute). (UNITS=INCH_MM)	Maximum Height for Component
.drc_mech	Boolean	Feature	(Obsolete)	Analysis Mechanical Area
.drc_min_height	Float	Feature	(0.0 to 10.0) Stores the minimum height of components to be allowed in a height restriction area (area with .drc_comp_height attribute). (UNITS=INCH_MM)	Minimum Height for Component
.drc_min_space	Integer	Mania_AOI	(1 to 100; default=5) (Obsolete)	Min Spacing
.drc_min_width	Integer	Mania_AOI	(1 to 100; default=7) (Obsolete)	Min Track Width
.drc_pad_keepout	Boolean	Feature	(YES, NO) Specifies area to be used as pads keepout boundary.	Pad Keep Out
.drc_pad_keepout_ly r	Text	Product Model	(0 to 64) Stores name of document layer in which all pad keepout areas are stored. Default as defined in the drc_pad_keepout configuration parameter.	Pad Keep Out Layer

Attribute	Type	Entity	Description	Display Name
.drc_plane_keepout	Boolean	Feature	(YES, NO) Specifies area to be used as planes keepout boundary	Plane Keep Out
.drc_plane_keepout_lyr	Text	Product Model	(0 to 64) Stores name of document layer in which all plane keepout areas are stored.	Plane Keep Out Layer
.drc_ref_des	Text	Feature	(0 to 100) Assigned to DRC areas defined for components.	Reference Designator
.drc_route_keepin	Boolean	Feature	(YES, NO) Specifies areas to be used as the rout keepin boundary (rout=lines, arcs, vias, pads and surfaces on signal and/or power and ground layers).	Route Keep In
.drc_route_keepin_lyr	Text	Product Model	(0 to 64) Stores name of document layer in which all rout keepin areas are stored.	Route Keep In Layer
.drc_route_keepout	Boolean	Feature	Specifies areas to be used as the rout keepout boundary (rout=lines, arcs, vias, pads and surfaces on signal and/or power and ground layers).	Route Keep Out
.drc_route_keepout_lyr	Text	Product Model	(0 to 64) Stores name of document layer in which all rout keepout areas are stored.	Route Keep Out Layer
.drc_tp_keepin	Boolean	Feature	Defines areas to be used as testpoint keepin area boundaries.	Testpoint Keep In
.drc_tp_keepin_lyr	Text	Product Model	(0 to 64) Stores name of document layer in which all testpoint keepin areas are stored.	Testpoint Keep In Layer
.drc_tp_keepout	Boolean	Feature	Specifies areas to be used as the testpoint keepout boundary.	Testpoint Keep Out

Attribute	Type	Entity	Description	Display Name
.drc_tp_keepout_lyr	Text	Product Model	(0 to 64) Stores name of document layer in which all testpoint keepout areas are stored.	Testpoint Keep Out Layer
.drc_trace_keepout	Boolean	Feature	(YES, NO) Defines areas to be used as trace keepout boundaries (traces=lines and arcs on signal and/or power and ground layers).	Trace Keep Out
.drc_trace_keepout_lyr	Text	Product Model	(0 to 64) Stores name of document layer in which all traces keepout areas are stored.	Trace Keep Out Layer
.drc_via_keepout	Boolean	Feature	(YES, NO) Defines areas to be used as vias keepout boundaries.	Via Keep Out
.drc_via_keepout_lyr	Text	Product Model	(0 to 64) Stores name of document layer in which all vias keepout areas are stored.	Via Keep Out Layer
.drill	Option	Feature	(plated; non_plated; via) Assigned to hole features in drill layers. It defines the type of the drill and is used extensively during fabrication analysis.	Drill Type
.drill_flag	Integer	Feature	(0 to 100000; default=0) (Obsolete)	Auto Drill Mgr Flag

Attribute	Type	Entity	Description	Display Name
.drill_layer_direction	Option	Layer	(top2bottom, bottom2top, any; default=top2bottom) Specifies the drill direction for all drills on a given layer. This information impacts on analysis and potentially on the generation of production tooling information. See START_NAME and END_NAME in “ Fields in the LAYER Array of a Matrix File ” on page 65.	Drill Layer Direction
.drill_noopt	Boolean	Feature	(Obsolete)	Auto Drill No Opt.
.drill_sr_zero	Option	Feature	(1; 2; 3) (Obsolete)	Auto Drill S and R Offset
.drill_stage	Option	Feature	(1; 2; 3) (Obsolete)	Auto Drill Mgr Stage
.dxf_dimension	Boolean	Feature	(YES, NO) Assigned during DXF file input to mark its features as part of a DXF dimension entity.	DXF Dimension
.eclass_accumulative_parallel_dist_list	Text	Net	(0-255) List of electrical class rules (blank-separated) defining the maximum distance between the two traces of nets considered parallel.	Accum. Parallel Dist. List
.eclass_accumulative_parallel_max_length_list	Text	Net	(0-255) List of electrical class rules (blank-separated) defining the maximum distance between the two traces of nets considered parallel.	Accum. Parallel Max. Len. List
.eclass_impedance	Float	Net	(0.0 to 1000.0) Electrical class rule	Impedance

Attribute	Type	Entity	Description	Display Name
.eclass_individual_parallel_dist_list	Text	Net	(0-255) List of blank-separated electrical class rules. Defines the separation distance within which two traces are considered parallel.	Individ. Parallel Dist. List
.eclass_individual_parallel_max_length_list	Text	Net	(0-255) List of electrical class rules (blank-separated). Defines the maximum length that two nets can run parallel to each other.	Individ. Parallel Max. Len. List
.eclass_individual_parallel_min_jog_list	Text	Net	(0-255) List of electrical class rules (blank-separated). Defines the distance parallel traces that deviate must maintain the deviation before it is considered a break in parallelism.	Individ. Parallel Min. Jog List
.eclass_max_stub_length	Float	Net	(0.0 to 100.0) Electrical class rule—high limit of the stub length. (UNITS=MIL_MICRON)	Max. Stub Length
.eclass_max_via_count	Integer	Net	(0 to 1000) Maximal number of vias on the nets.	Max. Via Count
.eclass_min_stub_length	Float	Net	(0.0 to 100.0) Electrical class rule—low limit of the stub length. (UNITS=MIL_MICRON)	Min. Stub Length
.eclass_rise_time	Float	Net	(0.0 to 100.0) Electrical class rule specifying the interval of a rising signal transition (low to high)	Rise Time
.eclass_voltage_swing	Float	Net	(0.0 to 100.0) Electrical class rule	Voltage Swing

Attribute	Type	Entity	Description	Display Name
.ecmp_layer_tech	Option	Layer	(none, additive, subtractive) Assigns a technology type attribute to an embedded components layer.	Embedded Passive Technology
.ecmp_max_value	Float	Feature	(0.0 to 1000000.0) Maximum nominal value received at input (its value plus a tolerance).	Embedded Passive Max. Value
.ecmp_min_value	Float	Feature	(0.0 to 1000000.0) Minimum value received at input (its value minus a tolerance).	Embedded Passive Min. Value
.ecmp_name	Text	Feature	(0 to 64 characters) Name assigned to an embedded passive feature.	Embedded Passive Name
.ecmp_type	Option	Feature	(resistor; capacitor) Assigns a component type to an embedded component.	Embedded Passive Type
.ecmp_value	Float	Feature	(0.0 to 1000000.0) Embedded passive nominal value. For resistors it is the resistance in ohms.	Embedded Passive Nominal Value
.eco	Text	Step	(0 to 100 characters) The engineering change list.	Engineering Change List
.eda_define_imp_line	Boolean	Feature	Defines lines controlled by impedance. Lines assigned this attribute are not re-routed nor shaved.	Impedance Line-No Edits
.eda_dimension_id	Integer	Feature	(0 to 100000; default=0) Assigns system-generated ID to dimensions	Embedded Passive Nominal Value

Attribute	Type	Entity	Description	Display Name
.eda_layers	Text	Layer	(0 to 1000) Contains the EDA system layer names that compose a physical layer. It is loaded during the direct EDA translation and is used for graphic synchronization with the EDA system.	EDA Layers
.electrical_class	Text	Net	(0 to 64) Electrical class name associating a net with a set of electrical call rules. Electrical class rules include physical and electrical limitations required to assure and analyze the signal integrity of a high speed net.	Electrical Class
.et_adjacency	Float	Layer	(0.0 to 1000.0; default=20.0) A distance value (per layer) to use in netlist adjacency calculation for moving probe testers (currently BSL and PROBOT). (UNITS=MIL_MICRON)	Adjacency Distance (ET)
.et_align	Boolean	Feature	(YES, NO) Determines that a feature will be used as an alignment target for PROBOT output	Probot Alignment Targets

Attribute	Type	Entity	Description	Display Name
.extended	Integer	Feature	(-1 to 100000; default=0) Assigned to construction features (lines and pads) added to assist in the generation of a rout path. These features have zero width and are not output to the rout machine as regular features. They are used, for example, as source elements from which to create actual features by dimensions. If the attribute value is not zero then the feature is an extended feature and the decimal value is its serial value in the layer (to be referenced in dimension creation).	Dimension Feature
.fab_drc	Text	Step	(0 to 20) Stores the default DRC area name. This name is applied when no specific area is defined in the DRC map layer, or no such map layer at all.	Fab DRC
.feature_ignore	Boolean	Feature	(YES, NO) Copper features with this attribute are ignored in analysis actions. (Currently implemented for rout tests only.)	Copper Feature Ignore
.feed	Integer	Feature	(0 to 100000; default=0) For a chained feature, this attribute sets the table feed rate when routing.	Rout Feed Rate
.fiducial_name	Text	Feature	(0 to 64) (Obsolete)	Etec Fiducial Output

Attribute	Type	Entity	Description	Display Name
.fiducial_rdlst	Text	Feature	(0-1000) This attribute is assigned local fiducial features. It can consist of a list of REFDES (separated by semicolons); a list of the component/s using this local fiducial.	Local Fiducial Ref.Des. List
.fill_dx	Float	Symbol	(0.000001 to 50.0; default=0.1) This attribute is used as the default horizontal distance between symbols when the symbol is used for pattern filling. (UNITS=INCH_MM)	Fill Dx
.fill_dy	Float	Symbol	(0.000001 to 50.0; default=0.1) This attribute is used as the default vertical distance between symbols when the symbol is used for pattern filling. (UNITS=INCH_MM)	Fill Dy
.foot_down	Boolean	Feature	(Default=NO) (Obsolete)	Auto Rout Footdown
.fs_direction_bottom	Option	Step	(Right2Left; Left2Right; Top2Bottom; Bottom2Top). Indicates the manufacturing direction the PCB will be going through during the flow solder process.	Flow Solder Direction (Bottom)
.fs_direction_top	Option	Step	(Left2Right; Right2Left; Top2Bottom; Bottom2Top) Indicates the manufacturing direction the PCB will be going through during the flow solder process.	Flow Solder Direction (Top)
.full_plane	Boolean	Feature	NOT USED	

Attribute	Type	Entity	Description	Display Name
.gencad_device_ntol	Float	Comp.; Pkg.	0-1000000; default=0.0) This is a real value expressing the percent of the value to use as a tolerance (negative tolerance). This is used for all devices: Range of characters: all floating point numbers.	GENCAD Negative Tolerance
.gencad_device_ptol	Float	Comp.; Pkg.	(0-1000000; default=0.0) This is a real value expressing the percent of the value to use as a tolerance (positive tolerance). This is used for all devices:	GENCAD Positive Tolerance
.gencad_device_style	Text	Comp.; Pkg.	(0-64) This attribute is an enhancement of .gencad_device_type and is used to store the style of the component as defined in GenCAD (such as, NPN, PNP, NFET, PFET, NJFET, PJFET, TTL, CMOS and ECL)	GENCAD Device Style
.gencad_device_type	Text	Comp.; Pkg.	(0-64) Stores the type of the component as defined in GenCAD (such as, RES, VRES, DIODE, ZENER, LOGIC, SWITCH, CONN, etc.).	GENCAD Device Type
.gencad_device_value	Text	Comp.; Pkg.	(0-64) Stores the electrical value of a component.	GENCAD Device Value
.geometry	Text	Feature	(0 to 500) Contains the name of the padstack that created this feature.	Geometry
.global_camtek_aoi-set	Text	Product Model	(0-80) (Obsolete)	Global CAMTEK aoi-set

Attribute	Type	Entity	Description	Display Name
.gold_plating	Boolean	Feature	Used during auto-panelization to orient the gold plated area toward the extreme side of the panel.	Gold Plating
.gold_plating_defined_by	Option	Step	(GoldMask; SolderMask; N/A; default=GoldMask). Type of gold plating used.	Gold Plating Defined by
.guard_comp	Boolean	Comp.; Pkg.	(Default=NO) Assigned to a component that 'guards' other components. If TRUE, this component is considered a 'guard component' (that is, not likely to be knocked off the board accidentally. To be used in future actions.)	Component Guard
.hatch	Boolean	Feature	(YES, NO) Assigned to hatched planes (filled with lines—hatches—or cross lines—cross-hatch—instead of solid copper). The lines that make up the border and fill the surface are hatches.	Hatch
.hatch_border	Boolean	Feature	(YES, NO) The lines making up the border of a surface.	Hatch Border
.hatch_serrated_border	Boolean	Feature	(YES, NO) Assigned to features that are added for partial hatch. The difference between regular hatch and partial hatch is that in partial hatch the cells along the border that intersect the border line are filled; the feature(s) that fill these cells are assigned this attribute.	Hatch Serrated Border

Attribute	Type	Entity	Description	Display Name
.hdi_assembly_tech	Option	Layer	(None, WireBond, FlipChip, Hybrid) The attribute defines the type of HDI assembly technology identified in the product model. If None, the special layer is not created.	HDI assembly technology
.hdi_drc	Text	Step	(0 to 20) Default area name applied to all HDI actions.	HDI Assembly Technology
.hp3070_comment	Text	Comp.; Pkg.	(0-64) (Obsolete)	HP 3070 Comment
.hp3070_common_pin	Text	Comp.; Pkg.	(0 to 16). (Obsolete)	HP 3070 Common Pin
.hp3070_contact_pin	Text	Comp.; Pkg.	(0 to 16). (Obsolete)	HP 3070 Contact Pin
.hp3070_device	Text	Comp.; Pkg.	(0 to 16) (Obsolete)	HP 3070 Contact Pin
.hp3070_fail_msg	Text	Comp.; Pkg.	(0-64) (Obsolete)	HP 3070 Fail Message
.hp3070_hi_value	Float	Comp.; Pkg.	(0-100000.0; default=0.0) (Obsolete)	HP 3070 High Value
.hp3070_lo_value	Float	Comp.; Pkg.	(0-100000.0; default=0.0) (Obsolete)	HP 3070 Low Value
.hp3070_probe_access	Text	Feature; Comp.	(0-64) (Obsolete)	HP 3070 Contact Pin
.hp3070_seriesr	Float	Comp.; Pkg.	(0-100000.0; default=0.0) (Obsolete)	HP 3070 Series
.hp3070_test	Boolean	Comp.; Pkg.	(Default=NO) (Obsolete)	HP 3070 Test
.hp3070_tol_neg	Float	Comp.; Pkg.	(0-100; default=0.0) (Obsolete)	HP 3070 Negative Tolerance
.hp3070_tol_pos	Float	Comp.; Pkg.	(0-100; default=0.0) (Obsolete)	HP 3070 Positive Tolerance

Attribute	Type	Entity	Description	Display Name
.hp3070_type	Text	Comp.; Pkg.	(0-8) (Obsolete)	HP 3070 Type
.hp3070_value	Text	Comp.; Pkg.	(0-16) (Obsolete)	HP 3070 Value
.ignore_net	Boolean	Net	(YES, NO) When this attribute is assigned to a net, it is ignored during Testpoint Allocation Analysis. No potential testpoints are assigned, they are not reported in the Nets without Potential TPs category, the Testpoints Allocation Report, or in Total Number of Nets.	Ignore Net During Allocation
.image_dx .image_dy	Float	Symbol	(-1.0 to 50.0; default=-1.0) These values are set when inputting Image files into the system. They contain the datum point of an Image user-defined symbol entity used to set the datum when performing output back into Image format. These values should not be changed by the user as this can cause data corruption. (UNITS=INCH_MM)	Image Dx Image Dy
.imp_constraint_id	Integer	Feature	(0 to 2 ³²) For each impedance line bearing this attribute, the system refers to the constraint with the given ID in the impedance constraints table.	Impedance Constraint ID
.imp_line	Boolean	Feature	Assigned to lines that are impedance-controlled. When set, it prevents the lines from being rerouted or thinned during signal layer optimization.	Impedance Line

Attribute	Type	Entity	Description	Display Name
.imp_polyline_id	Integer	Feature	(0 to 2^{32}) Defines a unique ID for all trace segments that are part of the same impedance polyline.	Impedance Polyline ID
.impedance_test_width	Float	Layer	(0 to 1000) Test width of routes used for the provided impedance (UNITS=MIL_MICRON)	Impedance Test Width
.ind_orient_req	Boolean	Comp.; Pkg.	(Default=NO) Indicates that the component requires silkscreen orientation indication. (To be used in future actions.)	Orientation Indication Required
.inp_file	Text	Layer	(0 to 500) Contains the name of the file (Gerber, Drill) from which the data was input into the layer.	Input File
.ipc_class	Option	Product Model	(Class1; Class2; Class3; default=Class1) Defines the end-product class according to IPC-7351.	IPC Performance Class
.ipc_via_type_bottom	Text	Feature	(0-100; default=0) Assigned to a via drill to indicate one of the IPC-4761 Via types for via tenting, covering, plugging and capping. Refers to the bottom side of the via drill.	IPC-4761 Bottom Via Type
.ipc_via_type_top	Text	Feature	(0-100; default=0) Assigned to a via drill to indicate one of the IPC-4761 Via types for via tenting, covering, plugging and capping. Refers to the top side of the via drill.	IPC-4761 Top Via Type

Attribute	Type	Entity	Description	Display Name
.is_buried	Boolean	Comp.; Pkg.	(Default=NO) Assigned to buried components.	Buried Component
.is_capped	Boolean	Feature	(Obsolete) Used on via pads on top and bottom signal layers to indicate that the via is capped on this side.	Capped Via
.is_shadowed	Boolean	Comp.; Pkg.	(Default=NO) Components with this attribute are considered vulnerable to component shadowing.	Check for Shadowing
.is_shield	Boolean	Comp.; Pkg.	(Default=NO) Components with this attribute assigned are designated as a shield.	Shield
.is_wirebonded	Boolean	Comp.; Pkg.	(Default=NO) Defines a component to be wire-bonded.	Wirebonded Component
.label_clearance	Boolean	Comp.; Pkg.	(Default=NO) Assigned to components that are not allowed to be too close to a glued label (e.g. fine pitch SOIC components).	Label Clearance
.layer_class	Text	Layer	(0 to 1000 characters) Used to differentiate between layers.	Layer Class
.layer_dielectric	Float	Layer	(0.0) Applies to layers of type DIELECTRIC or SOLDERMASK in the layer matrix that contains the thickness of material according to its specified Units of Measurement . (UNITS=INCH_MM)	Thickness of Material

Attribute	Type	Entity	Description	Display Name
.layer_hdi_type	Option	Layer	(Buildup; Core) An attribute added to a copper layer—not a dielectric layer—to distinguish buildup layers from core layers in HDI product models.	HDI Layer Type
.layer_side	Option	Layer	(Top, Bottom, Inner, None) Used to identify the location of a layer in the board stackup. For layers not in the board (such as documentation layers), “None” is used.	Layer Side
.lead_form	Text	Comp.	Used to classify components by lead type. Options: gw-small; gw; j-bend; l-bend; c-bend-wrap; side-concave; corner-concave; end-cap; other; flat-insulated; qfn; lcc; capae; m-column; lga; ball; axial; radial; inline; wire; pin; pressfit; mixed	Lead Form
.local_fiducial_dist	Float	Comp.; Pkg.	(0.0 to 100.0) Defines the allowed distance of fiducials from the outline of the components that require local fiducials (See the attribute .num_local_fiducial.) If set to 0, the fiducials must be included INSIDE the outline. (UNITS=INCH_MM)	Search Distance for Local Fiducial
.loss_tangent	Float	Layer	(0-100; Default=0) The parameter of a dielectric material that quantifies its inherent dissipation of electromagnetic energy.	Loss Tangent

Attribute	Type	Entity	Description	Display Name
.lpol_done	Boolean	Layer	(Default=NO) Reflects the state of the product model in whether or not the polarity sort according to a format has already been performed.	Polarity Order was Done
.lpol_surf	Boolean	Feature	(Default=NO) Indicates surface modified by layer polarity reduction algorithm.	Polarity Optimization
.lyr_prf_ref	Integer	Feature	(0-100000; Default=0)	Layer Profile Reference Number
.machine_pkg	Text	Comp.; Pkg.	(0-100) Assigned to a component to indicate the name of a corresponding package in the assembly machine libraries.	Package Name for ALE
.mechanical	Boolean	Comp	(YES, NO) Components with this attribute are considered part of the MECHANICAL section of a GenCAD file.	GENCAD Mechanical
.merge_processes	Text	Step	(0-64) A list of the last three merge actions in the order in which they were run. The list is updated each time a merge (bom_merge, library_merge, board_merge) is run. It is for informational purposes and does not have to be changed by the user.	Assembly Merge Processes

Attribute	Type	Entity	Description	Display Name
.min_line_width	Float	Net.	(0.0-100.0) Assigned to nets that should have a minimum trace width, i.e. each line of the net should have a width of at least this value. If such nets have a split (the net traces split and then meet again) the sum of the split traces should be at least this value. (UNITS=MIL_MICRON)	Min. Line Width
.moat	Boolean	Feature	(YES, NO) Assigned to a moat feature added to a line or arc of the rout path.	Moat Feature
.mount_hole	Boolean	Feature	(YES, NO) Used on drill features to indicate that they are mounting holes.	Mounting Hole
.mount_stage	Integer	Comp.; Pkg.	(0-255; default=0) User-defined integer used to assign machine number in the assembly line where component is to be placed.	Placement Machine Number
.n_electric	Boolean	Feature	(YES, NO) Assigned to a feature, defines it as non-electric (it is not considered for the current netlist for the step).	Non Electrical Feature
.needs_guarding	Boolean	Comp.; Pkg.	(YES, NO) (Default=NO) YES—this component needs to be protected by guard components (see the attribute .guard_comp) else it is likely to be knocked off the board accidentally.	Require Guards
.net_length_max	Float	Net	(0.0 to 100.0) High limit of net length. (UNITS=INCH_MM)	Net Max. Length

Attribute	Type	Entity	Description	Display Name
.net_length_min	Float	Net	(0.0 to 100.0) Lower limit of net length. (UNITS=INCH_MM)	Net Min. Length
.net_name	Text	Feature; Layer	(0 to 10000) Set by the netlist layer. Contains the net name.	Net Name
.net_physical_type	Text	Feature	(0 to 64) Physical type of constraint area used for search in table that contains physical parameters of nets.	Net Physical Type
.net_point	Boolean	Feature	(YES, NO) When assigned to a pad in an inner layer, defines the pad as an internal test point.	Internal Net Point
.net_spacing_type	Text	Feature	(0 to 64) SQA area name of an SQA area map.	Net Spacing Type
.net_test_current	Float	Net	(0 to 100000) Nominal current associated with the corresponding net.	
.net_test_type	Option	Net	(signal; power; ground) Classification type of an electrical net: Signal, Power, or Ground.	
.net_test_voltage	Float	Net	(-100000 to 100000) Nominal voltage associated with the corresponding net.	
.net_type	Text	Net	(0 to 64) A name for the type of net. The .net_type attribute can reference the set of routing rules for a net.	Net Type

Attribute	Type	Entity	Description	Display Name
.neutralization_angle	Float	Comp.; Pkg.	(0.0 to 360.0) An attribute attached to each component stating the angle of rotation counter-clockwise from ODB++ standard orientation. Consideration of this value provides a rotation neutralized component.	Rotation Neutralization
.neutralization_info	Text	Step	(0 to 200) An attribute attached to a step indicating component rotation neutralization has occurred. This attribute contains the information <CPL CAD>;<DataCenter>; Site. where Site is a name representing the location at which the correction was performed.	Neutralization Information
.neutralization_ reviewed	Boolean	Comp.; Pkg.	(YES, NO) Attached to each component in a package reviewed for confirming component orientation correction conforms to ODB++ standard orientation.	Rotation Reviewed
.neutralization_ss_ layers	Text	Step	(0 to 200) Attached to the step where component orientations have been validated to ODB++ standard rotations through the use of the .neutralization_angle attribute. This attribute designates which layers are to be considered the silkscreen layers.	Neutralization Silkscreen

Attribute	Type	Entity	Description	Display Name
.no_copper_shape_under	Boolean	Comp.; Pkg.	(Default=NO) This attribute indicates that the component should not have copper pads or surfaces underneath it. See also the attribute .no_trace_under.	No Shape Under
.no_fiducial_check	Boolean	Comp.; Pkg.	(Default=NO) Components with this attribute do not require fiducials.	No Fiducial Check
.no_hole_under	Boolean	Comp.; Pkg.	(Default=NO) Indicates that no drill holes are allowed under the component.	No Hole Under
.no_pop	Boolean	Comp.; Pkg.	(YES, NO) Designates a component as being not populated for the current version of the BOM.	Not Populated per BOM
.no_protrude_board	Boolean	Comp	(YES, NO) Indicates that toeprint length (as defined by attribute .pin_length) should be less than the board thickness so that the pins do not protrude from the other side of the board.	Pins Cannot Protrude
.no_text_under	Boolean	Comp.; Pkg.	(Default=NO) Assigned to a component, does not allow silk screen text to be placed under the component outline. Printed components (e.g. edge connectors) may not have this attribute.	No Silkscreen Under

Attribute	Type	Entity	Description	Display Name
.no_tp_under	Boolean	Comp.; Pkg.	(Default=NO) Assigned to a component, does not allow testpoints to be placed under the component outline. Printed components (e.g. edge connectors) may not have this attribute.	No Test Point Under
.no_trace_under	Boolean	Comp.; Pkg.	(YES, NO) (Default=NO) YES—traces are NOT allowed under the component except for those that touch the component's toeprint pads and exit the component on that toeprint's side.	No Trace Under
.no_uncap_via_under	Boolean	Comp.; Pkg.	(YES, NO) (Default=NO) YES—uncapped vias are NOT allowed under this component.	No Uncapped Vias Under
.nomenclature	Boolean	Feature	(YES, NO) Defines a feature as a nomenclature (legend) feature.	Copper Text
.non_tp	Boolean	Feature	(YES, NO) Assigned to a feature causes it NOT to be considered as a net testpoint. It is used for connectivity calculation but is not used as a test point (bare board testing).	Non Test Point
.num_local_fiducials	Integer	Comp.; Pkg.	(0 to 20; default=0) Defines how many local fiducials are expected to be inside or near a component.	Number Local Fiducials Required
.orbotech_plot_stamp	Boolean	Feature	NOT USED	Orbotech Plot Stamp
.orig_surf	Integer	Feature	(0-2147483647; default=0) Identifies original surface that will be rebuilt.	Original Contour Index

Attribute	Type	Entity	Description	Display Name
.otherside_keepout	Option	Comp.; Pkg.	(full_area; pins_only; pads_only) Defines for components whether the other side of the board may also contain components in the same area.	No Components on Other Side
.out_angle	Option	Layer	(0.0; 90.0; 180.0; 270.0; default=0.0) Contains the output angle to be used when generating manufacturing data.	Output Angle
.out_break	Boolean	Feature; Symbol	(Default=NO) Indicates that upon output generation standard symbols and user-defined symbols should be replaced with basic primitive round and square symbols representing the intended shapes.	Output Break
.out_comp	Float	Layer	(-100.0 to 100.0; default=0.0) Layer entity attributes with default values that are used by the output translator.	Output Compensation
.out_drill_full	Boolean	Step	(Default=NO) This attribute can be used for a drill coupon that needs to be fully drilled before continuing to the next step and repeat entity.	Output Drill Full

Attribute	Type	Entity	Description	Display Name
.out_drill_optional	Boolean	Feature; Step	(Default=NO) If a drill feature is set with this attribute it will have the '/' command prefix in the final output file, indicating that the drill is optional. If a step entity attribute is set, then all the commands that are part of that step will have the '/' command prefixed. Thus, the whole step is optional.	Output Drill Optional
.out_drill_order	Integer	Step	(-10000 to 10000; default=0) The attribute controls the order in which the steps are drilled. That is, who is first, second, etc. The attribute has the following valid values: 0—no special order for that step 1—first 2—second 3—and above, order from the beginning -1—last -2—one before last -3—and on (drill order from the end)	Output Drill Order
.out_flag	Integer	Feature	(-1 to 1000000; default=-1) (Obsolete) Used for Excellon translation.	Excellon Unknown
.out_mirror	Boolean	Layer	(Default=NO) Indicates the output could be mirrored along the X- axis when generating manufacturing data.	Output Mirror
.out_name	Text	Step	(Obsolete)	Output Name

Attribute	Type	Entity	Description	Display Name
.out_orig	Boolean	Feature	(Obsolete)	Rout Output Origin
.out_polarity	Option	Layer	(Positive; Negative) Contains the output polarity to be used when generating manufacturing data.	Output Polarity
.out_rout_optional	Boolean	Feature; Step	(Default=NO) If drill feature is set with this attribute it will have the '/' command in front of it in the final output file. This means that the drill is optional. If a step entity attribute is set then all the commands that are part of that step will have the '/' command at the beginning. Thus, the whole step is optional.	Output Rout Optional
.out_rout_order	Integer	Step	(-10000 to 10000; default=0) The attribute controls the order in which the steps will be drilled. Thus, who is first, second, etc. The attribute has the following valid values: 0 —no special order for that step 1—first 2—second 3 and above—order from the beginning -1—last -3 and on—drill order from the end	Output Rout Order

Attribute	Type	Entity	Description	Display Name
.out_scale	Boolean	Feature; Symbol	(Default=NO) During the generation of manufacturing data, it may be required to specify whether certain features can be scaled or not. This is important in cases where special registration targets would not be scaled together with all the other features. This special output option applies only to features that have this attribute set. In the case of a user-defined symbol, setting the attribute enables you to control the scaling of all features using the symbol.	Output Scale
.out_x_scale	Float	Layer	(0.000001 to 5.0; default=1.0) Contains the output scale along the X-axis to be used when generating manufacturing data.	Output X Scale
.out_y_scale	Float	Layer	(0.000001 to 5.0; default=1.0) Contains the output scale along the Y-axis to be used when generating manufacturing data.	Output Y Scale
.output_dcode	Integer	Feature	(0 -1000000) Assigned to features to provide action codes for an assembly machine, such as the GSI Lumonics laser cutter.	GSI Lumonics Output Dcode

Attribute	Type	Entity	Description	Display Name
.package_type	Text	Comp.	(1 to 64 characters) Used to classify components by package type. Options: melf; axial; radial; cyl-tall; cc; chip; connector; fp; ga; sip-dip; smt-misc; so; thru-misc	Package Type
.package_version	Text	Comp.; Pkg.	(0 to 50) Used for Zuken Board Designer translation.	Zuken Package Info
.pad_usage	Option	Feature	(toeprint; via; g_fiducial; l_fiducial; tooling_hole) This attribute defines the specific usage of a pad.	Pad Usage
.padstack_id	Integer	Feature	(0 to 2^{32}) Defines an ID for all pads attached to the same drill. The value should be unique in the context of the board.	Padstack ID
.part_desc1...10	Text	Comp.; Pkg.	(0 to 1000) Ten BOM description fields.	Part Description 1 ... Part Description 10
.patch	Boolean	Feature	(YES, NO) Assigned to features added to eliminate pin holes.	Copper Patch
.pattern_fill	Boolean	Feature	(YES, NO) Assigned to features that represent a pattern fill, typically used for copper balancing. Best practice in copper balancing is to use zero length lines where X/Y start is the same as X/Y end (rather than pads) to support manufacturing that requires data preparation.	Copper Balancing

Attribute	Type	Entity	Description	Display Name
.pf_optimized	Boolean	Feature	(YES, NO) This attribute describes the state of the product model. It is attached to a padstack that has had non-functional pads removed.	Optimized Pad Stack
.physical_type	Text	Net	(0 to 64) Physical type of net.	Physical Type
.pilot_hole	Integer	Feature	(0 to 100000; default=0) Attribute assigned to pads that are pilot holes in a chain (holes that are drilled in each tool down in the chain rout path before routing the chain). The value of the attribute is the serial chain number to which the pilot hole belongs. When merging or inserting chains, the pilot holes are updated automatically. (UNITS=MIL_MICRON)	Rout Pilot Hole
.pin_length	Float	Comp.	(0.0-10.0) The length of TH component pins. (UNITS=INCH_MM)	Pin Length
.pin_name	Text	Comp.	Name of the die bump.	Name of Die Bump
.pitch	Float	Feature	NOT USED	
.placement_layer	Text	Comp.; Pkg.	(0 - 64) Receives the value of the EMBEDDED_LAYER parameter from the Cadence Allegro file <i>pins_<product model>.out</i> .	Placement Layer
.plated_type	Option	Feature	(Standard, Press_fit) Defines plated hole type for drill tools.	Through Hole Type
.plug_vias	Boolean	Step	(Obsolete) Indicates whether vias should be plugged.	Plug Vias

Attribute	Type	Entity	Description	Display Name
.polarity_marker	Integer	Comp.; Pkg.	(1-10000; default=1) An attribute indicating which pin of the component is Pin 1.	Polarity Indicator Pin
.primary_side	Option	Product Model	(Top; Bottom) Indicates the primary side for this product model.	Primary Side
.producibility_level	Option	Product Model	(levela; levelb; levelc; default=levelb) Defines the design density level according to IPC-7351: <ul style="list-style-type: none"> • levela — Maximum (most) land protrusion • levelb — Medium (nominal) land protrusion • levelc — Minimum (least) land protrusion 	IPC-7531 Density Level
.rf	Option	Feature	(original; fixed) Defines the status of a radio frequency surface—whether or not they it has been enlarged by 10 pixels. original - indicates it has not been enlarged. fixed - indicates that it has been enlarged.	Radio Frequency Surface
.rot_correction	Integer	Comp.; Pkg.	(0-359) Component machine rotation correction to apply.	Rotation Correction
.rout_chain	Integer	Feature	(0 to 100000; default=0) Contains the serial number of the chain to which the feature belongs. Features belonging to that chain are rearranged in the features file according to their order inside the chain. Additional attributes that are added to a chained feature: .feed, .speed, .rout_flag, .comp.	Rout Chain

Attribute	Type	Entity	Description	Display Name
.rout_flag	Integer	Feature	(0 to 100000; default=0). For each chained feature this attribute represents a numeric value supplied to a chain.	Rout Flag
.rout_plated	Boolean	Feature	Indicates that a feature on a rout layer is plated. The .drill attribute is still used in rout layers, but the .rout_plated attribute takes precedence on rout layers, if both exist.	Plated Rout
.shave	Boolean	Feature	(Default=NO) Assigned to negative features used to optimize layer content for manufacturing purposes.	Silkscreen Shaved
.sip	Option	Feature	(Detected / Repaired). Indicates the presence of a SIP (self-intersecting polygon).	Self Intersecting Polygon
.sliver_fill	Boolean	Feature	(YES, NO) Assigned to all features added to eliminate slivers.	Sliver Fill Patch
.smd	Boolean	Feature	(YES, NO) Assigned to outer layer pads designated as toeprints that are lands for SMD components.	SMD
.smt_direction_bottom	Option	Step	(Left2Right; Top2Bottom; Right2Left; Bottom2Top) Defines the direction of the SMT process flow on the bottom side.	SMT Direction (Bottom)
.smt_direction_top	Option	Step	(Left2Right; Top2Bottom; Right2Left; Bottom2Top) Defines the direction of the SMT process flow on the top side.	SMT Direction (Top)

Attribute	Type	Entity	Description	Display Name
.soldermask_define_no_edits	Boolean	Feature	Defines the exposed copper region. Outer layer features and soldermask features assigned this attribute define the region.	Soldermask Defined Pad-No Edits
.source_llyer	Text	Feature	(0-64) This attribute identifies the Source Logical Layer of features (traces) appearing on signal or mixed layers.	Source Layer
.spacing_req	Float	Feature	(0.0 to 100.0) (UNITS=MILS_MICRONS)	Spacing Required
.speed	Integer	Feature	(0 to 100000; default=0) For a chained feature this attribute sets the spindle speed (in revolutions per minute) when routing.	Rout Spindle Speed
.spo_h_fact	Float	Feature; Comp.	(0.3 <-> 2.0; default=0.8) When .spo_h_mode = Factor, .spo_h_fact specifies the factor by which paste pad heights are sized relative to their SMD pads. For example, 0.9 means height is 90% of SMD pad.	Solderpaste Height Factor Value
.spo_h_mode	Option	Feature; Comp.	(Distance, Factor, Value) Defines how heights of paste pads are sized: by distance, factor or value.	Create Solderpaste Height Mode

Attribute	Type	Entity	Description	Display Name
.spo_h_val	Float	Feature; Comp.	(-500 to +500; default=5) When .spo_h_mode=Distance, .spo_h_val is the reduction/ expansion in mils or microns of the paste pad width relative to the SMD pad width. For example, .sp_h_val=5.0 mils shrinks paste pad by 5.0 mils (2.5 mils on each side) relative to SMD pad width. Positive number results in smaller paste pad, negative number in larger paste pad. When .spo_h_mode=Value, .spo_h_val becomes the absolute width of the paste pad (for example, 5.0 mils becomes the actual width of the paste pad). (UNITS=MIL_ MICRON)	Solderpaste Height Relative Value
.spo_move_center	Float	Feature; Comp.	(range: -500 to 500, default=0) To move the paste pad from the SMD pad center. A positive value will move the paste from the component center out. A negative value will move the paste towards the component center. (UNITS=MIL_MICRON)	Shift Solderpaste Symbol
.spo_p_fact	Float	Feature; Comp.	(0.3 <-> 2.0; default=0.8) When .spo_p_mode=Factor, .spo_p_fact specifies the factor by which paste pad heights are sized relative to their SMD pads. For example, 0.9 means area is 90% of SMD pad.	Solderpaste Nonstandard Factor Value

Attribute	Type	Entity	Description	Display Name
.spo_p_mode	Option	Feature; Comp.	(Distance, Area) Defines how paste pads for non-standard symbol SMD pads are sized: by distance, or area.	Create Solderpaste Nonstandard Mode
.spo_p_val	Float	Feature; Comp.	(-500 to 500; default=5) When .spo_p_mode=Distance, .spo_p_val is the reduction/expansion of the paste pad width relative to the SMD pad width expressed in mils or microns. For example, .sp_p_val=5.0 mils shrinks paste pad by 5.0 mils (2.5 mils on each side) relative to SMD pad width. Positive number results in smaller paste pad, negative number in larger paste pad. (UNITS=MIL_MICRON)	Create Solderpaste Nonstandard Mode
.spo_s_fact	Float	Feature; Comp.	(0.3 <-> 2.0; default=0.8) When .spo_s_mode=Factor, .spo_s_fact specifies the factor by which paste pad heights are sized relative to their non-standard SMD pads. For example, 0.9 means height is 90% of SMD pad.	Solderpaste Symmetric Factor Value
.spo_s_mode	Option	Feature; Comp.	(Distance, Factor, Value, Area) Defines how heights of paste pads for symmetric SMD pads are sized: by distance, factor, value, area.	Create Solderpaste Symmetric Mode

Attribute	Type	Entity	Description	Display Name
.spo_s_val	Float	Feature; Comp.	(-500 to 500; default=5) When .spo_s_mode=Distance, .spo_s_val is the reduction/ expansion expressed in mils or microns of the paste pad width relative to their non- standard SMD pad width. When .spo_h_mode=Value, .spo_h_val becomes the absolute size of the paste pad. (UNITS=MIL_MICRON)	Solderpaste Symmetric Relative Value
.spo_shape	Text	Feature; Comp.	Specifies the symbol to be used as the solder paste pad applied to a feature (smd pad) or to the toeprints of a component. The initial orientation of the symbol is also affected by the .spo_shape_rotate attribute when defined.	Apply Solderpaste Symbol
.spo_shape_rotate	Float	Feature; Comp.	(0 to 360; default=0) Specifies the initial rotation of the symbol defined in the .spo_shape attribute. Both .spo_shape_rotate and .spo_shape should appear as a pair at the level at which they are activated (component or feature). This means, for example, that an .spo_shape_rotate defined without a corresponding .spo_shape in the feature level is ignored.	Apply Solderpaste Rotation

Attribute	Type	Entity	Description	Display Name
.spo_shape_stretch	Boolean	Feature; Comp.	(Default=NO) Specifies that the symbol defined in .spo_shape is to be stretched to fit the copper pad dimensions. The stretch limits are determined by applying the SPO width and height parameters (pp_w_*, pp_h_*) or attributes (.spo_w_*, .spo_h_*) on the copper pad bounding box. Both .spo_shape_stretch and .spo_shape should appear as a pair at the level at which they are activated (component or feature). This means, for example, that an .spo_shape_stretch defined without a corresponding .spo_shape in the feature level is ignored.	Extend Solderpaste Symbol
.spo_w_fact	Float	Feature, Comp.	(0.3 <-> 2.0; default=0.8) When .spo_w_mode=Factor, .spo_w_fact specifies the factor by which paste pad widths are sized relative to their SMD pads. For example, .spo_w_fact=0.9 width of paste pad is 90% of width of SMD pad.	Solderpaste Width Factor Value
.spo_w_mode	Option	Feature, Comp.	(Distance; Factor; Value; Area) Defines how widths of paste pads are sized: by distance, factor or value.	Create Solderpaste Wide Mode

Attribute	Type	Entity	Description	Display Name
.spo_w_val	Float	Feature, Comp.	(-500 to 500; default=5) When .spo_w_mode=Distance, .spo_w_val is the reduction/ expansion expressed in mils or microns of the paste pad width relative to the SMD pad width. For example, .sp_w_val=5.0 mils shrinks paste pad by 5.0 mils (2.5 mils on each side) relative to SMD pad width. Positive number results in smaller paste pad, negative number in larger paste pad. When .spo_w_mode=Value, .spo_w_val becomes the absolute width of the paste pad (for example, 5.0 mils becomes the actual width of the paste pad). (UNITS=MIL_MICRON)	Solderpaste Width Relative Value
.src_orientation	Integer	Comp.	(-1 to 3; default=-1) Defines the zero orientation of this component relative to its orientation in the packages database. That is, the orientation of the component on the automated assembly tape, or (for manually inserted components) the orientation in which pin #1 is 'in the same position' for all similar components.	Source Orientation
.station	Text	Comp.; Pkg.	NOT USED (Min_len= 0, Max_len=255)	ALE Station

Attribute	Type	Entity	Description	Display Name
.string	Text	Feature	(0 to 1000) For nomenclature features, the value of this attribute is the original text string of which the feature is a part. See “ TEXT Attribute Definition ” on page 88.	Copper Text String
.string_angle	Float	Feature	(0 to 360) For nomenclature features, the value of this attribute is the original (in the input file) text rotation angle of which the feature is a part.	String Angle
.string_font	Text	Feature	(1 to 100 characters) For nomenclature features, the value of this attribute is the font of the original text string of which this feature is a part.	String Font
.string_justification	Option	Feature	String justification: tl, tc, tr, cl, cc, cr, bl, bc, br tl, tc, tr — top-left, top-center, top-right cl, cc, cr — center-left, center-center, center-right bl, bc, br — bottom-left, bottom-center, bottom-right (Default= bl)	String Justification
.string_mirrored	Boolean	Feature	(YES, NO) Assigned to mirrored strings.	String Mirror
.tear_drop	Boolean	Feature	(YES, NO) Assigned to features representing a tear drop.	Tear Drop Feature
.teardrop_addition_allowed_on_inner	Boolean	Step	Indicates whether it is allowed to add teardrops on inner copper layers.	Teardrop Addition Allowed on Inner
.teardrop_addition_allowed_on_outer	Boolean	Step	Indicates whether it is allowed to add teardrops on outer copper layers.	Teardrop Addition Allowed on Outer

Attribute	Type	Entity	Description	Display Name
.technology	Text	Product Model	(0-100) Defines the technology used in creating the product model.	Technology
.test_point	Boolean	Feature	(YES, NO) Assigned to features that are used for In-Circuit Testing operations.	ICT Test Point
.test_potential	Option	Feature	An attribute attached to features being considered as testpoints (potential testpoints) for In-Circuit Testing operations. potential_tp_by_analysis—a feature meeting all criteria of the Testpoint Allocation Action. potential_tp_manually—a feature to be used as a testpoint though it does not meet all criteria. not_potential_tp_manually—a feature not to be used as a testpoint even though it meets all criteria.	Test Point Potential
.testpoint_count	Integer	Net	(-1 to 10000) Specifies the number of testpoints expected on this net. If this variable is not defined, or its value is -1 , the number of expected testpoints is unlimited. A value of -1 is given to a net that does not require a specific number of test points.	Expected Test Point Count
.testpoint_name	Text	Feature	(0 to 64) Name of the testpoint.	Testpoint Name

Attribute	Type	Entity	Description	Display Name
.testprobe_diameter	Float	Feature	(10 to 10000; default=30) Used to provide information on the size of test probes. (UNITS=MIL_MICRON)	Test Probe Diameter
.thickness_over_cu	Float	Step	(1.0 to 1000.0; default=1.0) (UNITS=MIL_MICRON)	Total Thickness over Copper
.thickness_over_sm	Float	Step	(1.0 to 1000.0; default=1.0) (UNITS=MIL_MICRON)	Total Thickness over Soldermask
.thypad_required	Boolean	Comp.; Pkg.	(Default=NO) Assigned to components that require thieving pads (such as fine pitch SOIC).	Thieving Pad Required
.toep_nochk_o_side	Boolean	Comp.; Pkg.	(Default=NO) Assigned to components so that their toeprints on the opposite side will not be taken into account.	Toeprint Spacing on Placement Side
.toep_spacing_req	Float	Comp.; Pkg.	(1 to 500; default=5) Defines for components the maximum pad to pad spacing measurements. (UNITS=MIL_MICRON)	Required Toeprint Spacing
.tooling_hole	Boolean	Feature	(YES, NO) Used on drill features to indicate that they are tooling holes.	Tooling Hole
.user_bom_rev	Text	Comp.; Pkg.	(0-1000) Used to describe user modified component extensions.	User Define Extension
.variant_list	Text	Product Model	(0-1000) Consists of a list of all possible variants of a product model. The list contains variant names separated by a colon (:). See “Component Variants” on page 41.	Product Model Variant List

Attribute	Type	Entity	Description	Display Name
.vcut	Boolean	Feature	(YES, NO) Assigned to rout features that are cut in a V-shape.	V-Score Edge
.via_in_pad	Boolean	Feature	(YES, NO) Assigned to via drills located in copper surfaces or pads. To define a via drill as filled and plated over (VIPPO), set this attribute in combination with .ipc_via_type_top=7 and .ipc_via_type_bottom=7.	Via in Pad
.via_tenting	bool	Step	(Obsolete) Indicates whether there are tented vias.	Via Tenting
.via_type	Option	Feature	(Drilled; Laser; Photo) Assigned to via drills for further classification.	Via Type
.viacap_layer	Option	Step	(Obsolete) (Top; Bottom; Both; None; default=None) Defines on which layer via capping can occur, if any.	Via Capping on Layer
.vpl1_pkg_name	Text	Comp.	(0 to 100 characters) The old name of the package of this component, in VPL1.	VPL Package Name (BVPL1)
.wheel_type	Option	Wheel	(Gerber; Tools) Specifies for a wheel whether it is used for Gerber files translation or for drill file translation.	Wheel Type
.z0impedance	Float	Layer	(0.0 to 10000.0; default=0.0) The typical characteristic impedance (in ohms) required for a layer.	Z0/Impedance

ODB++ System Attributes by Class

ODB++ system attributes are listed here by class. For each class, the name of the sysattr file is indicated, in which attribute definitions are stored for the class.

For a description of attributes, see “[ODB++ System Attributes - Alphabetical List](#)” on page 215.

See “[Attribute Classes](#)” on page 27.

Attributes are listed for these classes:

Product (sysattr)	271
DFM (sysattr.dfm)	276
Fabrication (sysattr.fab)	279
Assembly (sysattr.assy)	281
Test (sysattr.test)	283
Generic (sysattr.gen)	284

Product (sysattr)

These attributes support the product.

Table B-1. ODB++ Product Attributes

ODB++ Product Attributes
.all_eda_layers
.allowed_to_remove_non_functional_pads
.artwork
.board_thickness
.break_away
.brk_point
.bulk_resistivity
.cad_local_footprint_change
.cad_package_name
.cad_part_override
.centroid_correction_x
.centroid_correction_y
.comment

Table B-1. ODB++ Product Attributes (cont.)

ODB++ Product Attributes
.comp_height
.comp_height_area
.comp_height_max
.comp_htol_minus
.comp_htol_plus
.comp_polarity
.comp_variant_list
.comp_weight
.copper_weight
.critical_net
.critical_tp
.cu_base
.current_variant
.customer
.data_source
.desc1....10
.design_center
.design_origin_x
.design_origin_y
.dielectric_constant
.diff_pair
.drill
.drill_layer_direction
.ecmp_layer_tech
.ecmp_max_value
.ecmp_min_value
.ecmp_name
.ecmp_value
.eco
.eda_define_imp_line

Table B-1. ODB++ Product Attributes (cont.)

ODB++ Product Attributes
.eda_dimension_id
.eda_layers
.fiducial_rdlst
.geometry
.gold_plating
.gold_plating_defined_by
.hatch
.hatch_border
.hatch_serrated_border
.ignore_net
.imp_constraint_id
.imp_line
.imp_polyline_id
.impedance_test_width
.inp_file
.ipc_class
.ipc_via_type_bottom
.ipc_via_type_top
.is_buried
.is_capped
.is_shield
.is_wirebonded
.layer_dielectric
.layer_hdi_type
.loss_tangent
.lyr_prf_ref
.mechanical
.merge_processes
.moat
.mount_hole

Table B-1. ODB++ Product Attributes (cont.)

ODB++ Product Attributes
.n_electric
.net_name
.net_physical_type
.net_point
.net_spacing_type
.net_type
.neutralization_angle
.neutralization_info
.neutralization_reviewed
.neutralization_ss_layers
.no_pop
.nomenclature
.non_tp
.package_version
.pad_usage
.padstack_id
.part_desc1...10
.patch
.pattern_fill
.pf_optimized
.pitch
.plated_type
.plug_vias
.polarity_marker
.primary_side
.producibility_level
.rout_plated
.shave
.sip
.sliver_fill

Table B-1. ODB++ Product Attributes (cont.)

ODB++ Product Attributes
.smd
.soldermask_define_no_edits
.source_llyer
.string
.string_angle
.string_justification
.string_mirrored
.tear_drop
.teardrop_addition_allowed_on_inner
.teardrop_addition_allowed_on_outer
.technology
.test_point
.test_potential
.testpoint_name
.testprobe_diameter
.thickness_over_cu
.thickness_over_sm
.tooling_hole
.user_bom_rev
.variant_list
.vcut
.via_in_pad
.via_tenting
.via_type
.viacap_layer
.wheel_type
.z0impedance

DFM (sysattr.dfm)

These attributes support Design For Manufacture (DFM).

Table B-2. ODB++ DFM Attributes

ODB++ DFM Attributes
.ar_pad_drill_bottom_max
.ar_pad_drill_bottom_min
.ar_pad_drill_inner_max
.ar_pad_drill_inner_min
.ar_pad_drill_top_max
.ar_pad_drill_top_min
.ar_sm_drill_bottom_max
.ar_sm_drill_bottom_min
.ar_sm_drill_top_max
.ar_sm_drill_top_min
.ar_sm_pad_bottom_max
.ar_sm_pad_bottom_min
.ar_sm_pad_top_max
.ar_sm_pad_top_min
.area_name
.center_fiducial
.comp_ign_spacing
.comp_ignore
.comp_mount_type
.comp_type
.comp_type2
.dpair_gap
.drc_assembly_lyrs
.drc_bend_keepout
.drc_board
.drc_comp_height
.drc_comp_height_lyr

Table B-2. ODB++ DFM Attributes (cont.)

ODB++ DFM Attributes
.drc_comp_keepin
.drc_comp_keepin_lyr
.drc_comp_keepout
.drc_comp_keepout_lyr
.drc_etch_lyrs
.drc_etch_lyrs_all
.drc_etch_lyrs_bit
.drc_max_height
.drc_mech
.drc_min_height
.drc_pad_keepout
.drc_pad_keepout_lyr
.drc_plane_keepout
.drc_plane_keepout_lyr
.drc_ref_des
.drc_route_keepin
.drc_route_keepin_lyr
.drc_route_keepout
.drc_route_keepout_lyr
.drc_tp_keepin
.drc_tp_keepin_lyr
.drc_tp_keepout
.drc_tp_keepout_lyr
.drc_trace_keepout
.drc_trace_keepout_lyr
.drc_via_keepout
.drc_via_keepout_lyr
.eclass_accumulative_parallel_dist_list
.eclass_accumulative_parallel_max_length_list
.eclass_impedance

Table B-2. ODB++ DFM Attributes (cont.)

ODB++ DFM Attributes
.eclass_individual_parallel_dist_list
.eclass_individual_parallel_max_length_list
.eclass_individual_parallel_min_jog_list
.eclass_max_stub_length
.eclass_max_via_count
.eclass_min_stub_length
.eclass_rise_time
.eclass_voltage_swing
.electrical_class
.fab_drc
.feature_ignore
.guard_comp
.hdi_assembly_tech
.hdi_drc
.ind_orient_req
.is_shadowed
.label_clearance
.layer_class
.layer_side
.lead_form
.local_fiducial_dist
.min_line_width
.needs_guarding
.net_length_max
.net_length_min
.no_copper_shape_under
.no_fiducial_check
.no_hole_under
.no_protrude_board
.no_text_under

Table B-2. ODB++ DFM Attributes (cont.)

ODB++ DFM Attributes
.no_tp_under
.no_trace_under
.no_uncap_via_under
.num_local_fiducials
.otherside_keepout
.package_type
.physical_type
.pin_length
.placement_layer
.rf
.spacing_req
.src_orientation
.string_font
.testpoint_count
.thvpad_required
.toep_nochk_o_side
.toep_spacing_req

Fabrication (sysattr.fab)

These attributes support fabrication.

Table B-3. ODB++ Fabrication Attributes

ODB++ Fabrication Attributes
.aoi_cpbm
.aoi_cpcu
.aoi_drbm
.aoi_drcu
.aoi_value
.array_with_rotation
.backdrill_penetrate_stop_layer

Table B-3. ODB++ Fabrication Attributes (cont.)

ODB++ Fabrication Attributes
.bit
.comp
.cut_line
.drc_add_rad
.drc_min_space
.drc_min_width
.drill_flag
.drill_noopt
.drill_sr_zero
.drill_stage
.et_adjacency
.et_align
.extended
.feed
.fiducial_name
.fill_dx
.fill_dy
.foot_down
.full_plane
.global_camtek_aoiset
.image_dx
.image_dy
.lpol_done
.lpol_surf
.orbotech_plot_stamp
.out_angle
.out_break
.out_comp
.out_drill_full
.out_drill_optional

Table B-3. ODB++ Fabrication Attributes (cont.)

ODB++ Fabrication Attributes
.out_drill_order
.out_flag
.out_mirror
.out_name
.out_orig
.out_polarity
.out_rout_optional
.out_rout_order
.out_scale
.out_x_scale
.out_y_scale
.pilot_hole
.rout_chain
.rout_flag
.speed

Assembly (sysattr.assy)

These attributes support assembly.

Table B-4. ODB++ Assembly Attributes

ODB++ Assembly Attributes
.assembly_proc_bottom
.assembly_proc_top
.axi_direction
.bond_name
.bonding_profile
.comp_name
.device_style
.device_type
.device_value

Table B-4. ODB++ Assembly Attributes (cont.)

ODB++ Assembly Attributes
.device_value_ntol
.device_value_ptol
.ecmp_type
.fs_direction_bottom
.fs_direction_top
.gencad_device_ntol
.gencad_device_ptol
.gencad_device_style
.gencad_device_type
.gencad_device_value
.machine_pkg
.mount_stage
.pin_name
.rot_correction
.smt_direction_bottom
.smt_direction_top
.spo_h_fact
.spo_h_mode
.spo_h_val
.spo_move_center
.spo_p_fact
.spo_p_mode
.spo_p_val
.spo_s_fact
.spo_s_mode
.spo_s_val
.spo_shape
.spo_shape_rotate
.spo_shape_stretch
.spo_w_fact

Table B-4. ODB++ Assembly Attributes (cont.)

ODB++ Assembly Attributes
.spo_w_mode
.spo_w_val
.station
.vpl1_pkg_name

Test (sysattr.test)

These attributes support testing.

Table B-5. ODB++ Test Attributes

ODB++ Test Attributes
.board_mark
.hp3070_comment
.hp3070_common_pin
.hp3070_contact_pin
.hp3070_device
.hp3070_fail_msg
.hp3070_hi_value
.hp3070_lo_value
.hp3070_probe_access
.hp3070_seriesr
.hp3070_test
.hp3070_tol_neg
.hp3070_tol_pos
.hp3070_type
.hp3070_value
.net_test_current
.net_test_type
.net_test_voltage

Generic (sysattr.gen)

These are generic attributes.

Table B-6. ODB++ Generic Attributes

ODB++ Generic Attributes
.color
.dxf_dimension
.orig_surf
.output_dcode

Appendix C

Standard Font

This section contains the font definition for the font Standard used for ODB++ text. The file is not part of the ODB++ format, but the geometry of character and letter representations is part of the ODB++ format.

The format of a *fonts* file is described in “[fonts \(Fonts Used in Product Model\)](#)” on page 48.

```
XSIZE 0.302000
YSIZE 0.302000
OFFSET 0.000000
```

```
CHAR !
LINE 0.000000 0.000000 0.000000 0.200000 P R 0.012000
LINE 0.000000 -0.100000 0.000000 -0.100000 P R 0.012000
ECHAR
```

```
CHAR "
LINE -0.050000 0.100000 -0.050000 0.200000 P R 0.012000
LINE 0.050000 0.100000 0.050000 0.200000 P R 0.012000
ECHAR
```

```
CHAR #
LINE -0.050000 -0.100000 -0.050000 0.200000 P R 0.012000
LINE 0.050000 -0.100000 0.050000 0.200000 P R 0.012000
LINE -0.100000 0.000000 0.100000 0.000000 P R 0.012000
LINE -0.100000 0.100000 0.100000 0.100000 P R 0.012000
ECHAR
```

```
CHAR $
LINE 0.000000 -0.100000 0.000000 0.200000 P R 0.012000
LINE -0.100000 -0.050000 0.050000 -0.050000 P R 0.012000
LINE 0.050000 -0.050000 0.100000 0.000000 P R 0.012000
LINE 0.100000 0.000000 0.050000 0.050000 P R 0.012000
LINE 0.050000 0.050000 -0.050000 0.050000 P R 0.012000
LINE -0.050000 0.050000 -0.100000 0.100000 P R 0.012000
LINE -0.100000 0.100000 -0.050000 0.150000 P R 0.012000
LINE -0.050000 0.150000 0.100000 0.150000 P R 0.012000
ECHAR
```

```
CHAR %
LINE -0.100000 -0.100000 0.100000 0.200000 P R 0.012000
LINE -0.075000 0.175000 -0.075000 0.175000 P R 0.012000
LINE 0.075000 -0.075000 0.075000 -0.075000 P R 0.012000
ECHAR
```

```
CHAR &
LINE 0.100000 -0.100000 -0.100000 0.100000 P R 0.012000
LINE -0.100000 0.100000 -0.100000 0.150000 P R 0.012000
LINE -0.100000 0.150000 -0.050000 0.200000 P R 0.012000
LINE -0.050000 0.200000 0.000000 0.150000 P R 0.012000
LINE 0.000000 0.150000 0.000000 0.100000 P R 0.012000
LINE 0.000000 0.100000 -0.100000 0.000000 P R 0.012000
LINE -0.100000 0.000000 -0.100000 -0.050000 P R 0.012000
LINE -0.100000 -0.050000 -0.050000 -0.100000 P R 0.012000
LINE -0.050000 -0.100000 0.000000 -0.100000 P R 0.012000
LINE 0.000000 -0.100000 0.100000 0.000000 P R 0.012000
ECHAR
```

```
CHAR '
LINE 0.000000 0.050000 0.050000 0.150000 P R 0.012000
LINE 0.025000 0.175000 0.025000 0.175000 P R 0.012000
ECHAR
```

```
CHAR (
```

```
LINE 0.050000 -0.100000 -0.050000 0.000000 P R 0.012000
LINE -0.050000 0.000000 -0.050000 0.100000 P R 0.012000
LINE -0.050000 0.100000 0.050000 0.200000 P R 0.012000
ECHAR

CHAR )
LINE -0.050000 -0.100000 0.050000 0.000000 P R 0.012000
LINE 0.050000 0.000000 0.050000 0.100000 P R 0.012000
LINE 0.050000 0.100000 -0.050000 0.200000 P R 0.012000
ECHAR

CHAR *
LINE -0.100000 -0.050000 0.100000 0.150000 P R 0.012000
LINE -0.100000 0.150000 0.100000 -0.050000 P R 0.012000
LINE 0.000000 -0.100000 0.000000 0.200000 P R 0.012000
ECHAR

CHAR +
LINE -0.100000 0.050000 0.100000 0.050000 P R 0.012000
LINE 0.000000 -0.050000 0.000000 0.150000 P R 0.012000
ECHAR

CHAR ,
LINE 0.000000 -0.100000 0.050000 0.000000 P R 0.012000
LINE 0.025000 0.025000 0.025000 0.025000 P R 0.012000
ECHAR

CHAR -
LINE -0.100000 0.050000 0.100000 0.050000 P R 0.012000
ECHAR

CHAR .
LINE 0.025000 -0.075000 0.025000 -0.075000 P R 0.012000
ECHAR

CHAR /
LINE -0.100000 -0.050000 0.100000 0.150000 P R 0.012000
ECHAR

CHAR 0
LINE -0.100000 -0.050000 -0.050000 -0.100000 P R 0.012000
LINE -0.050000 -0.100000 0.050000 -0.100000 P R 0.012000
LINE 0.050000 -0.100000 0.100000 -0.050000 P R 0.012000
LINE 0.100000 -0.050000 0.100000 0.150000 P R 0.012000
LINE 0.100000 0.150000 0.050000 0.200000 P R 0.012000
LINE 0.050000 0.200000 -0.050000 0.200000 P R 0.012000
LINE -0.050000 0.200000 -0.100000 0.150000 P R 0.012000
LINE -0.100000 0.150000 -0.100000 -0.050000 P R 0.012000
LINE -0.100000 -0.050000 0.100000 0.150000 P R 0.012000
ECHAR

CHAR 1
LINE -0.050000 0.150000 0.000000 0.200000 P R 0.012000
LINE 0.000000 0.200000 0.000000 -0.100000 P R 0.012000
LINE -0.050000 -0.100000 0.050000 -0.100000 P R 0.012000
ECHAR

CHAR 2
```

```
LINE -0.100000 0.150000 -0.050000 0.200000 P R 0.012000
LINE -0.050000 0.200000 0.050000 0.200000 P R 0.012000
LINE 0.050000 0.200000 0.100000 0.150000 P R 0.012000
LINE 0.100000 0.150000 0.100000 0.100000 P R 0.012000
LINE 0.100000 0.100000 0.050000 0.050000 P R 0.012000
LINE 0.050000 0.050000 0.000000 0.050000 P R 0.012000
LINE 0.000000 0.050000 -0.100000 -0.100000 P R 0.012000
LINE -0.100000 -0.100000 0.100000 -0.100000 P R 0.012000
ECHAR
```

```
CHAR 3
```

```
LINE -0.100000 0.200000 0.100000 0.200000 P R 0.012000
LINE 0.100000 0.200000 0.100000 0.100000 P R 0.012000
LINE 0.100000 0.100000 0.050000 0.050000 P R 0.012000
LINE 0.050000 0.050000 0.000000 0.050000 P R 0.012000
LINE 0.050000 0.050000 0.100000 0.000000 P R 0.012000
LINE 0.100000 0.000000 0.100000 -0.050000 P R 0.012000
LINE 0.100000 -0.050000 0.050000 -0.100000 P R 0.012000
LINE 0.050000 -0.100000 -0.050000 -0.100000 P R 0.012000
LINE -0.050000 -0.100000 -0.100000 -0.050000 P R 0.012000
ECHAR
```

```
CHAR 4
```

```
LINE 0.050000 -0.100000 0.050000 0.200000 P R 0.012000
LINE 0.050000 0.200000 -0.100000 0.000000 P R 0.012000
LINE -0.100000 0.000000 0.100000 0.000000 P R 0.012000
ECHAR
```

```
CHAR 5
```

```
LINE 0.100000 0.200000 -0.100000 0.200000 P R 0.012000
LINE -0.100000 0.200000 -0.100000 0.100000 P R 0.012000
LINE -0.100000 0.100000 0.050000 0.100000 P R 0.012000
LINE 0.050000 0.100000 0.100000 0.050000 P R 0.012000
LINE 0.100000 0.050000 0.100000 -0.050000 P R 0.012000
LINE 0.100000 -0.050000 0.050000 -0.100000 P R 0.012000
LINE 0.050000 -0.100000 -0.050000 -0.100000 P R 0.012000
LINE -0.050000 -0.100000 -0.100000 -0.050000 P R 0.012000
ECHAR
```

```
CHAR 6
```

```
LINE 0.100000 0.200000 0.000000 0.200000 P R 0.012000
LINE 0.000000 0.200000 -0.100000 0.100000 P R 0.012000
LINE -0.100000 0.100000 -0.100000 -0.050000 P R 0.012000
LINE -0.100000 -0.050000 -0.050000 -0.100000 P R 0.012000
LINE -0.050000 -0.100000 0.050000 -0.100000 P R 0.012000
LINE 0.050000 -0.100000 0.100000 -0.050000 P R 0.012000
LINE 0.100000 -0.050000 0.100000 0.000000 P R 0.012000
LINE 0.100000 0.000000 0.050000 0.050000 P R 0.012000
LINE 0.050000 0.050000 -0.100000 0.050000 P R 0.012000
ECHAR
```

```
CHAR 7
```

```
LINE -0.100000 0.200000 0.100000 0.200000 P R 0.012000
LINE 0.100000 0.200000 -0.050000 -0.100000 P R 0.012000
ECHAR
```

```
CHAR 8
```

```
LINE -0.050000 0.200000 0.050000 0.200000 P R 0.012000
```

```
LINE -0.050000 0.050000 0.050000 0.050000 P R 0.012000
LINE -0.050000 -0.100000 0.050000 -0.100000 P R 0.012000
LINE -0.100000 0.150000 -0.100000 0.100000 P R 0.012000
LINE 0.100000 0.150000 0.100000 0.100000 P R 0.012000
LINE -0.100000 0.000000 -0.100000 -0.050000 P R 0.012000
LINE 0.100000 0.000000 0.100000 -0.050000 P R 0.012000
LINE 0.050000 0.200000 0.100000 0.150000 P R 0.012000
LINE -0.050000 0.200000 -0.100000 0.150000 P R 0.012000
LINE 0.050000 0.050000 0.100000 0.100000 P R 0.012000
LINE -0.050000 0.050000 -0.100000 0.100000 P R 0.012000
LINE 0.050000 0.050000 0.100000 0.000000 P R 0.012000
LINE -0.050000 0.050000 -0.100000 0.000000 P R 0.012000
LINE 0.050000 -0.100000 0.100000 -0.050000 P R 0.012000
LINE -0.050000 -0.100000 -0.100000 -0.050000 P R 0.012000
```

ECHAR

CHAR 9

```
LINE -0.100000 -0.100000 0.000000 -0.100000 P R 0.012000
LINE 0.000000 -0.100000 0.100000 0.000000 P R 0.012000
LINE 0.100000 0.000000 0.100000 0.150000 P R 0.012000
LINE 0.100000 0.150000 0.050000 0.200000 P R 0.012000
LINE 0.050000 0.200000 -0.050000 0.200000 P R 0.012000
LINE -0.050000 0.200000 -0.100000 0.150000 P R 0.012000
LINE -0.100000 0.150000 -0.100000 0.100000 P R 0.012000
LINE -0.100000 0.100000 -0.050000 0.050000 P R 0.012000
LINE -0.050000 0.050000 0.100000 0.050000 P R 0.012000
```

ECHAR

CHAR :

```
LINE 0.000000 -0.050000 0.000000 -0.050000 P R 0.012000
LINE 0.000000 0.150000 0.000000 0.150000 P R 0.012000
```

ECHAR

CHAR ;

```
LINE 0.000000 0.025000 -0.050000 -0.100000 P R 0.012000
LINE 0.000000 0.025000 0.000000 0.025000 P R 0.012000
LINE 0.000000 0.175000 0.000000 0.175000 P R 0.012000
```

ECHAR

CHAR <

```
LINE 0.100000 0.200000 -0.050000 0.050000 P R 0.012000
LINE -0.050000 0.050000 0.100000 -0.100000 P R 0.012000
```

ECHAR

CHAR =

```
LINE -0.100000 0.100000 0.100000 0.100000 P R 0.012000
LINE -0.100000 0.000000 0.100000 0.000000 P R 0.012000
```

ECHAR

CHAR >

```
LINE -0.100000 0.200000 0.050000 0.050000 P R 0.012000
LINE 0.050000 0.050000 -0.100000 -0.100000 P R 0.012000
```

ECHAR

CHAR ?

```
LINE -0.100000 0.150000 -0.050000 0.200000 P R 0.012000
LINE -0.050000 0.200000 0.050000 0.200000 P R 0.012000
LINE 0.050000 0.200000 0.100000 0.150000 P R 0.012000
```

```
LINE 0.100000 0.150000 0.000000 0.050000 P R 0.012000
LINE 0.000000 0.050000 0.000000 0.000000 P R 0.012000
LINE 0.000000 -0.100000 0.000000 -0.100000 P R 0.012000
ECHAR

CHAR @
LINE 0.050000 -0.100000 -0.050000 -0.100000 P R 0.012000
LINE -0.050000 -0.100000 -0.100000 -0.050000 P R 0.012000
LINE -0.100000 -0.050000 -0.100000 0.150000 P R 0.012000
LINE -0.100000 0.150000 -0.050000 0.200000 P R 0.012000
LINE -0.050000 0.200000 0.050000 0.200000 P R 0.012000
LINE 0.050000 0.200000 0.100000 0.150000 P R 0.012000
LINE 0.100000 0.150000 0.100000 0.000000 P R 0.012000
LINE 0.100000 0.000000 0.000000 0.000000 P R 0.012000
LINE 0.000000 0.000000 0.000000 0.100000 P R 0.012000
LINE 0.000000 0.100000 0.100000 0.100000 P R 0.012000
ECHAR

CHAR A
LINE -0.100000 -0.100000 -0.100000 0.150000 P R 0.012000
LINE -0.100000 0.150000 -0.050000 0.200000 P R 0.012000
LINE -0.050000 0.200000 0.050000 0.200000 P R 0.012000
LINE 0.050000 0.200000 0.100000 0.150000 P R 0.012000
LINE 0.100000 0.150000 0.100000 -0.100000 P R 0.012000
LINE -0.100000 0.050000 0.100000 0.050000 P R 0.012000
ECHAR

CHAR B
LINE -0.100000 0.200000 0.050000 0.200000 P R 0.012000
LINE 0.050000 0.200000 0.100000 0.150000 P R 0.012000
LINE 0.100000 0.150000 0.100000 0.100000 P R 0.012000
LINE 0.100000 0.100000 0.050000 0.050000 P R 0.012000
LINE 0.050000 0.050000 0.100000 0.000000 P R 0.012000
LINE 0.100000 0.000000 0.100000 -0.050000 P R 0.012000
LINE 0.100000 -0.050000 0.050000 -0.100000 P R 0.012000
LINE 0.050000 -0.100000 -0.100000 -0.100000 P R 0.012000
LINE -0.050000 -0.100000 -0.050000 0.200000 P R 0.012000
LINE -0.050000 0.050000 0.050000 0.050000 P R 0.012000
ECHAR

CHAR C
LINE 0.100000 -0.050000 0.050000 -0.100000 P R 0.012000
LINE 0.050000 -0.100000 -0.050000 -0.100000 P R 0.012000
LINE -0.050000 -0.100000 -0.100000 -0.050000 P R 0.012000
LINE -0.100000 -0.050000 -0.100000 0.150000 P R 0.012000
LINE -0.100000 0.150000 -0.050000 0.200000 P R 0.012000
LINE -0.050000 0.200000 0.050000 0.200000 P R 0.012000
LINE 0.050000 0.200000 0.100000 0.150000 P R 0.012000
ECHAR

CHAR D
LINE -0.100000 0.200000 0.050000 0.200000 P R 0.012000
LINE 0.050000 0.200000 0.100000 0.150000 P R 0.012000
LINE 0.100000 0.150000 0.100000 -0.050000 P R 0.012000
LINE 0.100000 -0.050000 0.050000 -0.100000 P R 0.012000
LINE 0.050000 -0.100000 -0.100000 -0.100000 P R 0.012000
LINE -0.050000 -0.100000 -0.050000 0.200000 P R 0.012000
ECHAR
```

CHAR E

LINE -0.100000 0.200000 0.100000 0.200000 P R 0.012000
LINE -0.100000 -0.100000 0.100000 -0.100000 P R 0.012000
LINE -0.100000 0.050000 0.050000 0.050000 P R 0.012000
LINE -0.100000 0.200000 -0.100000 -0.100000 P R 0.012000
ECHAR

CHAR F

LINE -0.100000 0.200000 0.100000 0.200000 P R 0.012000
LINE -0.100000 0.050000 0.050000 0.050000 P R 0.012000
LINE -0.100000 0.200000 -0.100000 -0.100000 P R 0.012000
ECHAR

CHAR G

LINE -0.050000 0.200000 0.100000 0.200000 P R 0.012000
LINE -0.050000 0.200000 -0.100000 0.150000 P R 0.012000
LINE -0.100000 0.150000 -0.100000 -0.050000 P R 0.012000
LINE -0.100000 -0.050000 -0.050000 -0.100000 P R 0.012000
LINE -0.050000 -0.100000 0.100000 -0.100000 P R 0.012000
LINE 0.100000 -0.100000 0.100000 0.050000 P R 0.012000
LINE 0.100000 0.050000 0.050000 0.050000 P R 0.012000
ECHAR

CHAR H

LINE -0.100000 0.200000 -0.100000 -0.100000 P R 0.012000
LINE 0.100000 0.200000 0.100000 -0.100000 P R 0.012000
LINE -0.100000 0.050000 0.100000 0.050000 P R 0.012000
ECHAR

CHAR I

LINE -0.050000 0.200000 0.050000 0.200000 P R 0.012000
LINE -0.050000 -0.100000 0.050000 -0.100000 P R 0.012000
LINE 0.000000 0.200000 0.000000 -0.100000 P R 0.012000
ECHAR

CHAR J

LINE 0.100000 0.200000 0.100000 -0.050000 P R 0.012000
LINE 0.100000 -0.050000 0.050000 -0.100000 P R 0.012000
LINE 0.050000 -0.100000 -0.050000 -0.100000 P R 0.012000
LINE -0.050000 -0.100000 -0.100000 -0.050000 P R 0.012000
ECHAR

CHAR K

LINE -0.100000 0.200000 -0.100000 -0.100000 P R 0.012000
LINE 0.100000 0.200000 -0.100000 0.050000 P R 0.012000
LINE -0.100000 0.050000 0.100000 -0.100000 P R 0.012000
ECHAR

CHAR L

LINE -0.100000 0.200000 -0.100000 -0.100000 P R 0.012000
LINE -0.100000 -0.100000 0.100000 -0.100000 P R 0.012000
ECHAR

CHAR M

LINE -0.100000 -0.100000 -0.100000 0.200000 P R 0.012000
LINE -0.100000 0.200000 0.000000 0.050000 P R 0.012000
LINE 0.000000 0.050000 0.100000 0.200000 P R 0.012000

LINE 0.100000 0.200000 0.100000 -0.100000 P R 0.012000
ECHAR

CHAR N

LINE -0.100000 -0.100000 -0.100000 0.200000 P R 0.012000
LINE -0.100000 0.200000 0.100000 -0.100000 P R 0.012000
LINE 0.100000 -0.100000 0.100000 0.200000 P R 0.012000
ECHAR

CHAR O

LINE -0.100000 -0.050000 -0.100000 0.150000 P R 0.012000
LINE -0.100000 0.150000 -0.050000 0.200000 P R 0.012000
LINE -0.050000 0.200000 0.050000 0.200000 P R 0.012000
LINE 0.050000 0.200000 0.100000 0.150000 P R 0.012000
LINE 0.100000 0.150000 0.100000 -0.050000 P R 0.012000
LINE 0.100000 -0.050000 0.050000 -0.100000 P R 0.012000
LINE 0.050000 -0.100000 -0.050000 -0.100000 P R 0.012000
LINE -0.050000 -0.100000 -0.100000 -0.050000 P R 0.012000
ECHAR

CHAR P

LINE -0.100000 -0.100000 -0.100000 0.200000 P R 0.012000
LINE -0.100000 0.200000 0.050000 0.200000 P R 0.012000
LINE 0.050000 0.200000 0.100000 0.150000 P R 0.012000
LINE 0.100000 0.150000 0.100000 0.100000 P R 0.012000
LINE 0.100000 0.100000 0.050000 0.050000 P R 0.012000
LINE 0.050000 0.050000 -0.100000 0.050000 P R 0.012000
ECHAR

CHAR Q

LINE -0.100000 -0.050000 -0.100000 0.150000 P R 0.012000
LINE -0.100000 0.150000 -0.050000 0.200000 P R 0.012000
LINE -0.050000 0.200000 0.050000 0.200000 P R 0.012000
LINE 0.050000 0.200000 0.100000 0.150000 P R 0.012000
LINE 0.100000 0.150000 0.100000 0.000000 P R 0.012000
LINE 0.100000 0.000000 0.000000 -0.100000 P R 0.012000
LINE 0.000000 -0.100000 -0.050000 -0.100000 P R 0.012000
LINE -0.050000 -0.100000 -0.100000 -0.050000 P R 0.012000
LINE 0.000000 0.000000 0.100000 -0.100000 P R 0.012000
ECHAR

CHAR R

LINE -0.100000 -0.100000 -0.100000 0.200000 P R 0.012000
LINE -0.100000 0.200000 0.050000 0.200000 P R 0.012000
LINE 0.050000 0.200000 0.100000 0.150000 P R 0.012000
LINE 0.100000 0.150000 0.100000 0.100000 P R 0.012000
LINE 0.100000 0.100000 0.050000 0.050000 P R 0.012000
LINE 0.050000 0.050000 -0.100000 0.050000 P R 0.012000
LINE -0.050000 0.050000 0.100000 -0.100000 P R 0.012000
ECHAR

CHAR S

LINE -0.100000 -0.050000 -0.050000 -0.100000 P R 0.012000
LINE -0.050000 -0.100000 0.050000 -0.100000 P R 0.012000
LINE 0.050000 -0.100000 0.100000 -0.050000 P R 0.012000
LINE 0.100000 -0.050000 0.100000 0.000000 P R 0.012000
LINE 0.100000 0.000000 0.050000 0.050000 P R 0.012000
LINE 0.050000 0.050000 -0.050000 0.050000 P R 0.012000

```
LINE -0.050000 0.050000 -0.100000 0.100000 P R 0.012000
LINE -0.100000 0.100000 -0.100000 0.150000 P R 0.012000
LINE -0.100000 0.150000 -0.050000 0.200000 P R 0.012000
LINE -0.050000 0.200000 0.050000 0.200000 P R 0.012000
LINE 0.050000 0.200000 0.100000 0.150000 P R 0.012000
ECHAR

CHAR T
LINE -0.100000 0.200000 0.100000 0.200000 P R 0.012000
LINE 0.000000 0.200000 0.000000 -0.100000 P R 0.012000
ECHAR

CHAR U
LINE -0.100000 0.200000 -0.100000 -0.050000 P R 0.012000
LINE -0.100000 -0.050000 -0.050000 -0.100000 P R 0.012000
LINE -0.050000 -0.100000 0.050000 -0.100000 P R 0.012000
LINE 0.050000 -0.100000 0.100000 -0.050000 P R 0.012000
LINE 0.100000 -0.050000 0.100000 0.200000 P R 0.012000
ECHAR

CHAR V
LINE -0.100000 0.200000 0.000000 -0.100000 P R 0.012000
LINE 0.000000 -0.100000 0.100000 0.200000 P R 0.012000
ECHAR

CHAR W
LINE -0.100000 0.200000 -0.100000 -0.100000 P R 0.012000
LINE -0.100000 -0.100000 0.000000 0.050000 P R 0.012000
LINE 0.000000 0.050000 0.100000 -0.100000 P R 0.012000
LINE 0.100000 -0.100000 0.100000 0.200000 P R 0.012000
ECHAR

CHAR X
LINE -0.100000 0.200000 0.100000 -0.100000 P R 0.012000
LINE -0.100000 -0.100000 0.100000 0.200000 P R 0.012000
ECHAR

CHAR Y
LINE -0.100000 0.200000 0.000000 0.050000 P R 0.012000
LINE 0.000000 0.050000 0.100000 0.200000 P R 0.012000
LINE 0.000000 0.050000 0.000000 -0.100000 P R 0.012000
ECHAR

CHAR Z
LINE -0.100000 0.200000 0.100000 0.200000 P R 0.012000
LINE 0.100000 0.200000 -0.100000 -0.100000 P R 0.012000
LINE -0.100000 -0.100000 0.100000 -0.100000 P R 0.012000
ECHAR

CHAR [
LINE 0.050000 0.200000 -0.050000 0.200000 P R 0.012000
LINE -0.050000 0.200000 -0.050000 -0.100000 P R 0.012000
LINE -0.050000 -0.100000 0.050000 -0.100000 P R 0.012000
ECHAR

CHAR \
LINE -0.100000 0.200000 0.100000 -0.100000 P R 0.012000
ECHAR
```

```
CHAR ]  
LINE -0.050000 0.200000 0.050000 0.200000 P R 0.012000  
LINE 0.050000 0.200000 0.050000 -0.100000 P R 0.012000  
LINE 0.050000 -0.100000 -0.050000 -0.100000 P R 0.012000  
ECHAR
```

```
CHAR ^  
LINE -0.100000 0.100000 0.000000 0.200000 P R 0.012000  
LINE 0.000000 0.200000 0.100000 0.100000 P R 0.012000  
ECHAR
```

```
CHAR _  
LINE -0.100000 -0.100000 0.100000 -0.100000 P R 0.012000  
ECHAR
```

```
CHAR `~  
LINE -0.050000 0.200000 0.000000 0.050000 P R 0.012000  
ECHAR
```

```
CHAR a  
LINE -0.050000 0.100000 0.050000 0.100000 P R 0.012000  
LINE 0.050000 0.100000 0.100000 0.050000 P R 0.012000  
LINE 0.100000 0.050000 0.100000 -0.100000 P R 0.012000  
LINE 0.100000 -0.100000 -0.050000 -0.100000 P R 0.012000  
LINE -0.050000 -0.100000 -0.100000 -0.050000 P R 0.012000  
LINE -0.100000 -0.050000 -0.050000 0.000000 P R 0.012000  
LINE -0.050000 0.000000 0.100000 0.000000 P R 0.012000  
ECHAR
```

```
CHAR b  
LINE -0.100000 0.200000 -0.100000 -0.100000 P R 0.012000  
LINE -0.100000 -0.100000 0.050000 -0.100000 P R 0.012000  
LINE 0.050000 -0.100000 0.100000 -0.050000 P R 0.012000  
LINE 0.100000 -0.050000 0.100000 0.050000 P R 0.012000  
LINE 0.100000 0.050000 0.050000 0.100000 P R 0.012000  
LINE 0.050000 0.100000 0.000000 0.100000 P R 0.012000  
LINE 0.000000 0.100000 -0.100000 0.050000 P R 0.012000  
ECHAR
```

```
CHAR c  
LINE 0.100000 0.100000 -0.050000 0.100000 P R 0.012000  
LINE -0.050000 0.100000 -0.100000 0.050000 P R 0.012000  
LINE -0.100000 0.050000 -0.100000 -0.050000 P R 0.012000  
LINE -0.100000 -0.050000 -0.050000 -0.100000 P R 0.012000  
LINE -0.050000 -0.100000 0.100000 -0.100000 P R 0.012000  
ECHAR
```

```
CHAR d  
LINE 0.100000 0.200000 0.100000 -0.100000 P R 0.012000  
LINE 0.100000 -0.100000 -0.050000 -0.100000 P R 0.012000  
LINE -0.050000 -0.100000 -0.100000 -0.050000 P R 0.012000  
LINE -0.100000 -0.050000 -0.100000 0.050000 P R 0.012000  
LINE -0.100000 0.050000 -0.050000 0.100000 P R 0.012000  
LINE -0.050000 0.100000 0.000000 0.100000 P R 0.012000  
LINE 0.000000 0.100000 0.100000 0.050000 P R 0.012000  
ECHAR
```

```
CHAR e
LINE 0.050000 -0.100000 -0.050000 -0.100000 P R 0.012000
LINE -0.050000 -0.100000 -0.100000 -0.050000 P R 0.012000
LINE -0.100000 -0.050000 -0.100000 0.050000 P R 0.012000
LINE -0.100000 0.050000 -0.050000 0.100000 P R 0.012000
LINE -0.050000 0.100000 0.050000 0.100000 P R 0.012000
LINE 0.050000 0.100000 0.100000 0.050000 P R 0.012000
LINE 0.100000 0.050000 0.050000 0.000000 P R 0.012000
LINE 0.050000 0.000000 -0.100000 0.000000 P R 0.012000
ECHAR
```

```
CHAR f
LINE -0.050000 -0.100000 -0.050000 0.150000 P R 0.012000
LINE -0.050000 0.150000 0.000000 0.200000 P R 0.012000
LINE 0.000000 0.200000 0.050000 0.200000 P R 0.012000
LINE 0.050000 0.200000 0.100000 0.150000 P R 0.012000
LINE -0.100000 0.050000 0.000000 0.050000 P R 0.012000
ECHAR
```

```
CHAR g
LINE -0.050000 -0.150000 0.050000 -0.150000 P R 0.012000
LINE 0.050000 -0.150000 0.100000 -0.100000 P R 0.012000
LINE 0.100000 -0.100000 0.100000 0.050000 P R 0.012000
LINE 0.100000 0.050000 0.050000 0.100000 P R 0.012000
LINE 0.050000 0.100000 -0.050000 0.100000 P R 0.012000
LINE -0.050000 0.100000 -0.100000 0.050000 P R 0.012000
LINE -0.100000 0.050000 -0.100000 0.000000 P R 0.012000
LINE -0.100000 0.000000 -0.050000 -0.050000 P R 0.012000
LINE -0.050000 -0.050000 0.100000 -0.050000 P R 0.012000
ECHAR
```

```
CHAR h
LINE -0.100000 0.200000 -0.100000 -0.100000 P R 0.012000
LINE -0.100000 0.050000 0.000000 0.100000 P R 0.012000
LINE 0.000000 0.100000 0.050000 0.100000 P R 0.012000
LINE 0.050000 0.100000 0.100000 0.050000 P R 0.012000
LINE 0.100000 0.050000 0.100000 -0.100000 P R 0.012000
ECHAR
```

```
CHAR i
LINE 0.000000 0.100000 0.000000 -0.050000 P R 0.012000
LINE 0.000000 -0.050000 0.050000 -0.100000 P R 0.012000
LINE 0.000000 0.200000 0.000000 0.200000 P R 0.012000
ECHAR
```

```
CHAR j
LINE 0.050000 0.100000 0.050000 -0.100000 P R 0.012000
LINE 0.050000 -0.100000 0.000000 -0.150000 P R 0.012000
LINE 0.000000 -0.150000 -0.050000 -0.150000 P R 0.012000
LINE -0.050000 -0.150000 -0.100000 -0.100000 P R 0.012000
LINE 0.050000 0.200000 0.050000 0.200000 P R 0.012000
ECHAR
```

```
CHAR k
LINE -0.100000 0.200000 -0.100000 -0.100000 P R 0.012000
LINE -0.100000 0.000000 0.000000 0.000000 P R 0.012000
LINE 0.000000 0.000000 0.100000 -0.100000 P R 0.012000
LINE -0.050000 0.000000 0.050000 0.100000 P R 0.012000
```

ECHAR

CHAR l

LINE -0.050000 0.200000 0.000000 0.200000 P R 0.012000
LINE 0.000000 0.200000 0.000000 -0.050000 P R 0.012000
LINE 0.000000 -0.050000 0.050000 -0.100000 P R 0.012000
ECHAR

CHAR m

LINE -0.100000 -0.100000 -0.100000 0.050000 P R 0.012000
LINE -0.100000 0.050000 -0.050000 0.100000 P R 0.012000
LINE -0.050000 0.100000 0.000000 0.050000 P R 0.012000
LINE 0.000000 0.050000 0.000000 0.000000 P R 0.012000
LINE 0.000000 0.050000 0.050000 0.100000 P R 0.012000
LINE 0.050000 0.100000 0.100000 0.050000 P R 0.012000
LINE 0.100000 0.050000 0.100000 -0.100000 P R 0.012000
ECHAR

CHAR n

LINE -0.100000 0.100000 -0.100000 -0.100000 P R 0.012000
LINE -0.100000 0.000000 0.000000 0.100000 P R 0.012000
LINE 0.000000 0.100000 0.050000 0.100000 P R 0.012000
LINE 0.050000 0.100000 0.100000 0.050000 P R 0.012000
LINE 0.100000 0.050000 0.100000 -0.100000 P R 0.012000
ECHAR

CHAR o

LINE -0.100000 -0.050000 -0.100000 0.050000 P R 0.012000
LINE -0.100000 0.050000 -0.050000 0.100000 P R 0.012000
LINE -0.050000 0.100000 0.050000 0.100000 P R 0.012000
LINE 0.050000 0.100000 0.100000 0.050000 P R 0.012000
LINE 0.100000 0.050000 0.100000 -0.050000 P R 0.012000
LINE 0.100000 -0.050000 0.050000 -0.100000 P R 0.012000
LINE 0.050000 -0.100000 -0.050000 -0.100000 P R 0.012000
LINE -0.050000 -0.100000 -0.100000 -0.050000 P R 0.012000
ECHAR

CHAR p

LINE -0.100000 -0.150000 -0.100000 0.050000 P R 0.012000
LINE -0.100000 0.050000 -0.050000 0.100000 P R 0.012000
LINE -0.050000 0.100000 0.050000 0.100000 P R 0.012000
LINE 0.050000 0.100000 0.100000 0.050000 P R 0.012000
LINE 0.100000 0.050000 0.100000 0.000000 P R 0.012000
LINE 0.100000 0.000000 0.050000 -0.050000 P R 0.012000
LINE 0.050000 -0.050000 -0.100000 -0.050000 P R 0.012000
ECHAR

CHAR q

LINE 0.100000 -0.150000 0.100000 0.050000 P R 0.012000
LINE 0.100000 0.050000 0.050000 0.100000 P R 0.012000
LINE 0.050000 0.100000 -0.050000 0.100000 P R 0.012000
LINE -0.050000 0.100000 -0.100000 0.050000 P R 0.012000
LINE -0.100000 0.050000 -0.100000 0.000000 P R 0.012000
LINE -0.100000 0.000000 -0.050000 -0.050000 P R 0.012000
LINE -0.050000 -0.050000 0.100000 -0.050000 P R 0.012000
ECHAR

CHAR r


```
LINE -0.100000 0.100000 -0.100000 -0.100000 P R 0.012000
LINE -0.100000 0.000000 0.000000 0.100000 P R 0.012000
LINE 0.000000 0.100000 0.050000 0.050000 P R 0.012000
ECHAR
```

```
CHAR s
LINE -0.100000 -0.100000 0.050000 -0.100000 P R 0.012000
LINE 0.050000 -0.100000 0.100000 -0.050000 P R 0.012000
LINE 0.100000 -0.050000 0.050000 0.000000 P R 0.012000
LINE 0.050000 0.000000 -0.050000 0.000000 P R 0.012000
LINE -0.050000 0.000000 -0.100000 0.050000 P R 0.012000
LINE -0.100000 0.050000 -0.050000 0.100000 P R 0.012000
LINE -0.050000 0.100000 0.100000 0.100000 P R 0.012000
ECHAR
```

```
CHAR t
LINE -0.050000 0.200000 -0.050000 -0.050000 P R 0.012000
LINE -0.050000 -0.050000 0.000000 -0.100000 P R 0.012000
LINE 0.000000 -0.100000 0.050000 -0.100000 P R 0.012000
LINE 0.050000 -0.100000 0.100000 -0.050000 P R 0.012000
LINE -0.100000 0.100000 0.050000 0.100000 P R 0.012000
ECHAR
```

```
CHAR u
LINE -0.100000 0.100000 -0.100000 -0.050000 P R 0.012000
LINE -0.100000 -0.050000 -0.050000 -0.100000 P R 0.012000
LINE -0.050000 -0.100000 0.000000 -0.100000 P R 0.012000
LINE 0.000000 -0.100000 0.100000 0.000000 P R 0.012000
LINE 0.100000 -0.100000 0.100000 0.100000 P R 0.012000
ECHAR
```

```
CHAR v
LINE -0.100000 0.100000 0.000000 -0.100000 P R 0.012000
LINE 0.000000 -0.100000 0.100000 0.100000 P R 0.012000
ECHAR
```

```
CHAR w
LINE -0.100000 0.100000 -0.050000 -0.100000 P R 0.012000
LINE -0.050000 -0.100000 0.000000 0.000000 P R 0.012000
LINE 0.000000 0.000000 0.050000 -0.100000 P R 0.012000
LINE 0.050000 -0.100000 0.100000 0.100000 P R 0.012000
ECHAR
```

```
CHAR x
LINE -0.100000 0.100000 0.100000 -0.100000 P R 0.012000
LINE -0.100000 -0.100000 0.100000 0.100000 P R 0.012000
ECHAR
```

```
CHAR y
LINE -0.100000 0.100000 -0.100000 0.000000 P R 0.012000
LINE -0.100000 0.000000 -0.050000 -0.050000 P R 0.012000
LINE -0.050000 -0.050000 0.100000 -0.050000 P R 0.012000
LINE 0.100000 0.100000 0.100000 -0.100000 P R 0.012000
LINE 0.100000 -0.100000 0.050000 -0.150000 P R 0.012000
LINE 0.050000 -0.150000 -0.050000 -0.150000 P R 0.012000
ECHAR
```

```
CHAR z
```

```
LINE -0.100000 0.100000 0.100000 0.100000 P R 0.012000
LINE 0.100000 0.100000 -0.100000 -0.100000 P R 0.012000
LINE -0.100000 -0.100000 0.100000 -0.100000 P R 0.012000
ECHAR
```

```
CHAR {
LINE 0.050000 0.200000 0.000000 0.200000 P R 0.012000
LINE 0.000000 0.200000 -0.050000 0.150000 P R 0.012000
LINE -0.050000 0.150000 -0.050000 0.100000 P R 0.012000
LINE -0.050000 0.100000 -0.100000 0.050000 P R 0.012000
LINE -0.100000 0.050000 -0.050000 0.000000 P R 0.012000
LINE -0.050000 0.000000 -0.050000 -0.050000 P R 0.012000
LINE -0.050000 -0.050000 0.000000 -0.100000 P R 0.012000
LINE 0.000000 -0.100000 0.050000 -0.100000 P R 0.012000
ECHAR
```

```
CHAR |
LINE 0.000000 0.200000 0.000000 -0.100000 P R 0.012000
ECHAR
```

```
CHAR }
LINE -0.050000 0.200000 0.000000 0.200000 P R 0.012000
LINE 0.000000 0.200000 0.050000 0.150000 P R 0.012000
LINE 0.050000 0.150000 0.050000 0.100000 P R 0.012000
LINE 0.050000 0.100000 0.100000 0.050000 P R 0.012000
LINE 0.100000 0.050000 0.050000 0.000000 P R 0.012000
LINE 0.050000 0.000000 0.050000 -0.050000 P R 0.012000
LINE 0.050000 -0.050000 0.000000 -0.100000 P R 0.012000
LINE 0.000000 -0.100000 -0.050000 -0.100000 P R 0.012000
ECHAR
```

```
CHAR ~
LINE -0.100000 0.150000 -0.050000 0.200000 P R 0.012000
LINE -0.050000 0.200000 0.050000 0.100000 P R 0.012000
LINE 0.050000 0.100000 0.100000 0.150000 P R 0.012000
ECHAR
```

Appendix D

Metadata Content, Example, and Schema

Product model metadata can be supplied in a *metadata.xml* file.

See “[misc/metadata.xml \(Metadata\)](#)” on page 79.

Metadata Content	300
Header Metadata Section	300
Requirements Metadata Section	301
Manufacturing Metadata Section	306
Assembly Metadata Section	310
Final Metadata Section	311
Metadata Example	312
Metadata Schema	316

Metadata Content

These node tags are supported by ODB++, and cannot be modified by a user. The tags are placed in the appropriate section of the *metadata.xml* file.

Header Metadata Section	300
Requirements Metadata Section	301
Manufacturing Metadata Section	306
Assembly Metadata Section	310
Final Metadata Section	311

Header Metadata Section

These are the tags in the header section.

Table D-1. Metadata Content - Header Section

Name	Description	Display Name	Type	Entity Level
buried_capacitor	Indicates whether this board contains buried capacitors.	Buried Capacitor	Boolean	product model
buried_resistor	Indicates whether this board contains buried resistors.	Buried Resistor	Boolean	product model
company_address	Company address.	Company Address	Text	product model
company_name	Company name.	Company Name	Text	product model
counter_bore	Indicates whether the board contains counter bore holes.	Counter Bore	Boolean	product model
countersink	Indicates whether the board contains countersink holes.	Counter Sink	Boolean	product model
customer_control_number	Revision control number assigned by the customer.	Customer Control Number	Text	product model
designer_email	Email address of designer.	Designer Email	Text	product model
designer_name	Name of designer.	Designer Name	Text	product model
designer_phone_number	Phone number of the designer.	Phone Number	Text	product model

Table D-1. Metadata Content - Header Section (cont.)

Name	Description	Display Name	Type	Entity Level
direct_connections_present	Indicates that direct connections to plans are known to exist.	Direct Connections Present	Boolean	step
edge_connectors	Indicates whether this board contains edge connectors.	Edge Connectors	Boolean	product model
layer_count	Number of copper layers in the board/panel.	Layer Count	Integer	product model
layout_name	Layout name.	Layout Name	Text	product model
part_x_size	Part size in the X direction.	Part X Size	Float (Distance)	step
part_y_size	Part size in the Y direction.	Part Y Size	Float (Distance)	step
pcb_part_number	Part number assigned to the PCB.	PCB Part Number	Text	product model
rohs_compliant	Indicates whether the process to produce the board or panel is ROHS compliant	RoHS Compliant	Boolean	product model
ruling_ipc_spec	(Class 1, Class 2, Class 3, ...) IPC classification	Ruling IPC Specification (Class 1, 2, 3, etc.)	Option	product model
stacked_vias_present	(yes/no) Indicates whether stacked vias are present.	Stacked Vias Present	Boolean	step
revision	(0-64 characters) Revision of this part.	Revision	Text	product model

Requirements Metadata Section

These are the tags in the requirements section.

Table D-2. Metadata Content - Requirements

Name	Description	Display Name	Type	Entity Level
additional_copper_ly r_require	Other requirements.	Additional Copper Layer Requirements	Text	step
additional_requirem ents	Other requirements.	Additional Requirements	Text	product model
board_outline_tolera nce_minus	Minus tolerance for board outline.	Board Outline Tolerance Minus	Float (Distance)	product model
board_outline_tolera nce_plus	Plus tolerance for board outline.	Board Outline Tolerance Plus	Float (Distance)	product model
board_thickness	Thickness of board.	Board Thickness	Float (Distance)	product model
board_thickness_tol _minus	Minus tolerance for board thickness.	Board Thickness Tol Minus	Float (Distance)	product model
board_thickness_tol _plus	Plus tolerance for board thickness.	Board Thickness Tol Plus	Float (Distance)	product model
board_thickness_typ e	(on foil, laminate, plated copper, mask on plated copper) Defines how the board thickness is measured/ specified.	Board Thickness Type	Text With Options	product model
bottom_legend_colo r	(white, yellow) Color of the silkscreen or legend on the bottom side of the design.	Bottom Legend Color	Text With Options	product model
bottom_soldermask_ color	(green, red, blue) Color of the soldermask on the bottom side of the design.	Bottom Soldermask Color	Text With Options	product model

Table D-2. Metadata Content - Requirements (cont.)

Name	Description	Display Name	Type	Entity Level
flammability_rating_standard	(UL 94, UL 94V-O) Materials used in the fabrication of a printed circuit board design should have one of these flammability ratings.	Flammability Rating Standard	Option	product model
general_pcb_standard	General PCB standard.	General PCB Standard	Text	product model
glass_transition_temperature_tg	Degree fahrenheit / Celsius	Glass Transition Temperature (Tg)	Float (Temperature)	product model
gold_plating_thickness_max	Required Max gold plating thickness.	Gold Plating Thickness Max	Float (Distance)	step
gold_plating_thickness_min	Required minimum gold plating thickness.	Gold Plating Thickness Min	Float (Distance)	step
hole_position_minus_tolerance	Minus tolerance for hole positions.	Hole Position Min Tolerance	Float (Distance)	step
hole_position_plus_tolerance	Plus tolerance for hole positions.	Hole Position Plus Tolerance	Float (Distance)	step
identify_soldermask_define_pads_that_need_to_remain_untouched	Defines whether the open area of soldermask defining a pad should remain unedited.	Identify Soldermask Defined Pads to Remain Untouched	Boolean	step
legend_clearance_from_component_pads	Minimum spacing between legend and edge of copper component pads.	Legend Clearance from Component Pads	Float (Distance)	step
legend_clearance_from_soldermask_clearance	Minimum spacing between legend and edge of soldermask clearances.	Legend Clearance from Soldermask Clearance	Float (Distance)	step

Table D-2. Metadata Content - Requirements (cont.)

Name	Description	Display Name	Type	Entity Level
legend_clearance_from_test_points	Minimum spacing between legend and edge of copper test pads.	Legend Clearance from Test Points	Float (Distance)	step
legend_sides	(none, top, bottom, both) Sides of the board on which legend printing must be applied.	Legend Sides	Option	product model
lyr_to_lyr_reg_max_tolerance	Maximum tolerance for layer to layer registration of copper layers.	Layer to Layer Registration Max Tolerance	Float (Distance)	step
max_bow_and_twist_of_the_pcb	Maximum bow and twist requirement for this part.	Max Bow and Twist of PCB	Float (Distance)	step
max_operating_temperature	Maximum operating temperature.	Max Operating Temperature	Float (Temperature)	product model
min_ar_blind_via	Minimum AR requirement for blind via holes.	Min AR Blind Via	Float (Distance)	step
min_ar_buried_via	Minimum AR requirement for buried via holes.	Min AR Buried Via	Float (Distance)	step
min_ar_pressfit_pth	Minimum AR requirement for Pressfit PTH.	Min AR Pressfit PTH	Float (Distance)	step
min_ar_pth	Minimum AR requirement for PTH.	Min AR PTH	Float (Distance)	step
min_ar_via	Minimum AR requirement for Via holes.	Min AR Via	Float (Distance)	step
min_copper_to_board_edge	Minimum spacing between copper and board edge.	Min Copper to Board Edge	Float (Distance)	step
min_hole_to_edge	Minimum hole to board edge spacing.	Min Hole To Edge	Float (Distance)	step
min_hole_to_hole	Minimum hole to hole spacing.	Min Hole To Hole	Float (Distance)	step
min_soldermask_clearance_for_bga_pads	Minimum soldermask clearance for BGA pads.	Min Soldermask Clearance for BGA Pads	Float (Distance)	step

Table D-2. Metadata Content - Requirements (cont.)

Name	Description	Display Name	Type	Entity Level
min_soldermask_clearance_for_npth	Minimum soldermask clearance for NPTH drills.	Min Soldermask Clearance for NPTH	Float (Distance)	step
min_soldermask_clearance_for_pth_pads	Minimum soldermask clearance for plated TH pads.	Min Soldermask Clearance for PTH Pads	Float (Distance)	step
min_soldermask_clearance_for_smd_pads	Minimum soldermask clearance for SMD pads.	Min Soldermask Clearance for SMD Pads	Float (Distance)	step
pcb_acceptability_standard	Standard for tolerances in the board.	PCB Acceptability Standard	Text	product model
peelable_mask_side	(none, top, bottom, both) Indicates whether peelable mask needs to be applied on this board, and if so, on which sides.	Peelable Mask Side	Option	product model
plated_edge	Indicates whether this job contains plated edges.	Plated Edge	Boolean	product model
plated_slots	Indicates whether this job contains plated slots.	Plated Slots	Boolean	product model
qualification_performance_std	Qualification and performance standard (free text).	Qualification and Performance Standard	Text	product model
soldermask_sides	(none, top, bottom, both) Indicates on which sides of the board soldermask must be applied.	Soldermask Sides	Option	product model
thermal_stress_requirement	Thermal stress requirements for the board.	Thermal Stress Requirement	Text	product model
tolerance_standard	Standard for tolerances in the board.	Tolerance Standard	Text	product model

Table D-2. Metadata Content - Requirements (cont.)

Name	Description	Display Name	Type	Entity Level
top_legend_color	(white, yellow) Color of the silkscreen or legend on the top side of the design.	Top Legend Color	Text With Options	product model
top_soldermask_color or	(none, green, white, yellow, black, blue, red) Color of the soldermask on the top side of the design.	Top Soldermask Color	Text With Options	product model

Manufacturing Metadata Section

These are the tags in the manufacturing section.

Table D-3. Metadata Content - Manufacturing

Name	Description	Display Name	Type	Entity Level
allowed_remove_nfp	Indicates whether it is allowed to remove non-functional pads.	Allowed To Remove Non-functional Pads	Boolean	step
barrel_cu_thickness_blind_via	Required copper thickness in the barrel of blind via holes.	Barrel Cu Thickness Blind Via	Float (Distance)	step
barrel_cu_thickness_buried_via	Required copper thickness in the barrel of buried via holes.	Barrel Cu Thickness Buried Via	Float (Distance)	step
barrel_cu_thickness_pressfit_pth	Required copper thickness in the barrel of Pressfit holes.	Barrel Cu Thickness Pressfit PTH	Float (Distance)	step
barrel_cu_thickness_pth	Required copper thickness in the barrel of PTH.	Barrel Cu Thickness PTH	Float (Distance)	step
barrel_cu_thickness_via	Required copper thickness in the barrel of Via holes.	Barrel Cu Thickness Via	Float (Distance)	step

Table D-3. Metadata Content - Manufacturing (cont.)

Name	Description	Display Name	Type	Entity Level
circuit_copper_repairs_allowed	(yes, only after approval, no) Indicates whether copper repairs, in order to resolve spacing problems, are allowed on the board.	PCB Circuit Copper Repairs Allowed	Text With Options	step
contour_processing_type	(rout, V-score, laser cutting) Indicates how the board can be cut from the panel.	Contour Processing Type	Text With Options	step
copper_area_percent	Percentage of copper.	Copper Area Percent	Float	step
date_stamp_format	(WWYY, YYWW, YYMM, MMY, LLMMYY, WWYY-LLL, YYWW-LLL, WW-YY-LLL, WWYYLL) Format of the date stamp. W = Week, Y = Year, M = Month, D = Day, L = Lot	Date Stamp Format	TextWith Options	step
date_stamp_required	Indicates whether a date stamp should be added on the board.	Date Stamp Required	Boolean	step
electrical_test_required	Indicates whether Electrical testing of this board is required.	Electrical Test Required	Boolean	step
fiducial_soldermask_clearance	Indicates the minimum soldermask clearance for fiducial pads.	Fiducial Soldermask Clearance	Float (Distance)	step
gold_plating_defined_by	(Gold Mask, Soldermask, NA) Type of gold plating used.	Gold Plating Defined by	Option	step
high_voltage_board	Indicates whether this board needs to be tested for high voltage.	High Voltage Board	Boolean	step
hole_breakout_allowed	Indicates whether a hole can break out of the copper pad.	Hole Breakout Allowed	Boolean	step

Table D-3. Metadata Content - Manufacturing (cont.)

Name	Description	Display Name	Type	Entity Level
legend_clipping_allowed	Indicates whether clipping of the legend to clear exposed copper from being covered by legend is allowed.	Legend Clipping Allowed	Boolean	step
lot	Production lot number for a board.	Production Lot Number	Text	step
mfg_id_stamp	Indicates whether a manufacturer identification stamp should be added on the board.	Manufacturer Identification Stamp	Boolean	step
min_conductor_width_inner	Minimum conductor width on inner layers.	Min Conductor Width Inner	Float (Size)	step
min_conductor_width_outer	Minimum conductor width on outer layers.	Min Conductor Width Outer	Float (Size)	step
min_copper_spacing_inner	Minimum copper spacing on inner layers.	Min Copper Spacing Inner	Float (Distance)	step
min_copper_spacing_outer	Minimum copper spacing on outer layers.	Min Copper Spacing Outer	Float (Distance)	step
number_of_drill_holes	Number of drill holes.	Number of Drill Holes	Integer	step
number_of_thru_pads	Number of thru pads.	Number of Thru Pads	Integer	step
number_of_tooling_holes	Number of tooling holes.	Number of Tooling Holes	Integer	step
number_of_unique_drill_sizes	Number of unique drill sizes.	Number of Unique Drill Sizes	Integer	step
number_of_vias	Number of vias.	Number of Vias	Integer	step
part_number_stamp	Indicates whether a Part number stamp should be added on the board.	Part Number Stamp	Boolean	step
plug_vias	Indicates whether vias should be plugged.	Plug Vias	Boolean	step

Table D-3. Metadata Content - Manufacturing (cont.)

Name	Description	Display Name	Type	Entity Level
print_et_test_stamp_on_board	Indicates whether it is required to print an ET stamp on the board.	Print ET Test Stamp on Board	Boolean	step
smallest_drill_size	Smallest drill size.	Smallest Drill Size	Float (Size)	step
smallest_trace_width	Smallest trace width.	Smallest Trace Width	Float (Size)	step
smallest_via_diameter	Smallest via diameter.	Smallest Via Diameter	Float (Size)	step
surface_finish_contact_fingers	(HASL, Lead-Free HASL, OSP (Intek), ENIG, Deep Gold, Wirebondable Gold, Bare Cu, Immersion Silver, White Tim, Other) Surface finish for contact fingers.	Surface Finish Contact Fingers	Text With Options	step
surface_finish_pads	(HASL, Lead-Free HASL, OSP (Intek), ENIG, Deep Gold, Wirebondable Gold, Bare Cu, Immersion Silver, White Tim, Other) Surface finish for exposed pads.	Surface Finish Pads	Text With Options	step
teardrop_allowed_on_inner	Indicates whether it is allowed to add teardrops on inner copper layers.	Teardrop Addition Allowed on Inner	Boolean	step
teardrop_allowed_on_outer	Indicates whether it is allowed to add teardrops on outer copper layers.	Teardrop Addition Allowed on Outer	Boolean	step
thieving_restrictions_on_inner	Restrictions for thieving patterns on inner layers (free text).	Thieving Restrictions on Inner	Text	step
thieving_restrictions_on_outer	Restrictions for thieving patterns on inner layers (free text).	Thieving Restrictions on Outer	Text	step

Table D-3. Metadata Content - Manufacturing (cont.)

Name	Description	Display Name	Type	Entity Level
ul_code_stamp	Indicates whether a UL Code stamp should be added on the board.	UL Code Stamp	Boolean	step
unique_serial_nr_stamp	Indicates whether a unique serial number stamp should be added on the board.	Unique Serial nr Stamp	Boolean	step
via_tenting	Indicates whether there are tented vias.	Via Tenting	Boolean	step
via_treatments	(Via Fill - Conductive, Via Fill - Non-conductive, Via Fill - Copper Plated, Via Fill - Soldermask Hole Filled, Via Capped, Clearance - Standard Soldermask Clearance, Dry Film Via Tenting, Soldermask Defined - Soldermask over Via) The via treatment that should be applied.	Via Treatments	Text With Options	step

Assembly Metadata Section

These are the tags in the requirements section.

Table D-4. Metadata Content - Assembly

Name	Description	Display Name	Data Type	Entity Level
cad_package_analysis	CAD package analysis: Number of unique cells per side and total with associated pin count and pin pitch.	CAD Package Analysis	Integer	step
complete_test_required	Indicates whether a test including barrel testing is required.	Complete Test Required	Boolean	step
component_count	Component count on board or panel.	Components per Step	Integer	step

Table D-4. Metadata Content - Assembly (cont.)

Name	Description	Display Name	Data Type	Entity Level
number_of_accessible_nets	Number of accessible nets.	Number of Accessible Nets		step
number_of_fiducials	Number of fiducials.	Number of Fiducials	Integer	step
number_of_multi_pin_nets	Number of multi-pin nets.	Number of Multi-pin Nets	Integer	step
number_of_nets	Number of nets.	Number of Nets	Integer	step
number_of_nets_with_probes	Number of nets with probes.	Number of Nets with Probes	Integer	step
number_of_single_pin_nets	Number of single pin nets.	Number of Single Pin Nets	Integer	step
number_of_test_points	Number of test points (net ends) on the board or panel.	Number of Test Points	Integer	step
number_of_unconnected_nets	Number of unconnected nets.	Number of Unconnected Nets	Integer	step
pressfit_technology	Indicates whether pressfit technology should be used on this board.	Pressfit Technology	Boolean	step
smallest_pin_pitch	Smallest pin pitch.	Smallest Pin Pitch	Float (Distance)	step
smd_technology	(single sided, double sided, none) The sides in the design that have SMD technology.	SMD Technology	Option	step
total_number_of_smd_pads	Total number of SMD pads.	Total Number of SMD Pads	Integer	step

Final Metadata Section

These are the tags in the final section.

Table D-5. Metadata Content - Final

Name	Description	Display Name	Data Type	Entity Type
qual_coupon_crosssection_rpt	Type of quality coupon cross section report (free text).	Quality Coupon Cross Section Report	Boolean	step
ship_as	(Single board, assembly panel) How the product is delivered.	Ship as	Option	step
solder_resist_adhesion_tst_rpt	Type of solder resist adhesion test report (free text).	Solder Resist Adhesion Test Report	Boolean	step
solderability_test_report	Type of solderability test report (free text).	Solderability Test Report	Boolean	step

Metadata Example

This is an example of a *metedata.xml* file.


```
<metadata>

<Header description="General Information" >

<node display="Buried Resistor" value="no" name="buried_resistor" />
<node display="Buried Capacitor" value="no" name="buried_capacitor" />
<node display="Company Address" value="Smallville" name="company_address"
/>
<node display="Company Name" value="OurCo" name="company_name" />
<node display="Counter Bore" value="no" name="counter_bore" />
<node display="Counter Sink" value="yes" name="countersink" />

...

</Header>

<Requirements description="Board Requirements" >

<node display="Additional Requirements" value=""
name="additional_requirements" />
<node display="Board Outline Tolerance Plus" units="MM" value=""
name="board_outline_tolerance_plus" />
<node display="Board Outline Tolerance Minus" units="MM" value=""
name="board_outline_tolerance_minus" />
<node display="Board Thickness" units="MM" value="1.71603"
name="board_thickness" />
<node display="Board Thickness Tol Plus" units="MM" value=""
name="board_thickness_tol_plus" />
<node display="Board Thickness Tol Minus" units="MM" value=""
name="board_thickness_tol_minus" />

...

</Requirements>

<Steps description="Steps" >

<Step name="cad" >

<Header description="General Information" >

<node display="Direct Connections Present" value=""
name="direct_connections_present" />
<node display="Part X Size" units="MM" value="235.6" name="part_x_size" />
<node display="Part Y Size" units="MM" value="447.68" name="part_y_size" /
>
<node display="Stacked Vias Present" value="" name="stacked_vias_present"
/>

</Header>

<Requirements description="Board Requirements" >

<node display="Additional Copper Layer Requirements" value=""
name="additional_copper_lyr_require" />
<node display="Gold Plating Thickness Min" units="MM" value=""
name="gold_plating_thickness_min" />
<node display="Gold Plating Thickness Max" units="MM" value=""
```

```
name="gold_plating_thickness_max" />
<node display="Hole Position Plus Tolerance" units="MM" value=""
name="hole_position_plus_tolerance" />
<node display="Hole Position Minus Tolerance" units="MM" value=""
name="hole_position_minus_tolerance" />
<node display="Identify Soldermask Define Pads that Need to Remain
Untouched" value=""
name="identify_soldermask_define_pads_that_need_to_remain_untouched" />

...

</Requirements>

<Manufacturing description="Manufacturing Process" >

<node display="Allowed to Remove non-functional Pads" value=""
name="allowed_remove_nfp" />
<node display="Barrel Cu Thickness Blind Via" units="MM" value=""
name="barrel_cu_thickness_blind_via" />
<node display="Barrel Cu Thickness Buried Via" units="MM" value=""
name="barrel_cu_thickness_buried_via" />
<node display="Barrel Cu Thickness Pressfit PTH" units="MM" value=""
name="barrel_cu_thickness_pressfit_pth" />
<node display="Barrel Cu Thickness PTH" units="MM" value=""
name="barrel_cu_thickness_pth" />
<node display="Barrel Cu Thickness Via" units="MM" value=""
name="barrel_cu_thickness_via" />

...

</Manufacturing>

<Assembly description="Assembly" >

<node display="Cad Package Analysis" value="53"
name="cad_package_analysis" >

<classify_by display="CAD Packages on Top Layer" value="36" name="Top" >

  <classify_by display="CAD Package" value="13" name="EB020A0" >
    <classify_by display="Pin Count" value="20" name="pin_count" />
    <classify_by display="Pitch" units="MM" value="1.27" name="pitch" />
  </classify_by>

  <classify_by display="CAD Package" value="1" name="EG064A3" >
    <classify_by display="Pin Count" value="65" name="pin_count" />
    <classify_by display="Pitch" units="MM" value="0.5" name="pitch" />
  </classify_by>

  ...

</classify_by>

<classify_by display="CAD Packages on Bottom Layer" value="17"
name="Bottom" >

  <classify_by display="CAD Package" value="2" name="EB048A0" >
    <classify_by display="Pin Count" value="50" name="pin_count" />
```

```
<classify_by display="Pitch" units="MM" value="0.5" name="pitch" />
</classify_by>

<classify_by display="CAD Package" value="11" name="EUF03S0" >
  <classify_by display="Pin Count" value="3" name="pin_count" />
  <classify_by display="Pitch" units="MM" value="1.8999975"
name="pitch" />
</classify_by>

...

</classify_by>

</node>

<node display="Complete Test Required" value=""
name="complete_test_required" />

<node display="Components per Step" value="2436" name="component_count" >
  <classify_by display="Components in Top Layer" value="677" name="Top" />
  <classify_by display="Components in Bottom Layer" value="1759"
name="Bottom" />
</node>

<node display="Number of Fiducials" value="16" name="number_of_fiducials"
>
  <classify_by display="Fiducials in Top Layer" value="8" name="Top" />
  <classify_by display="Fiducials in Bottom Layer" value="8" name="Bottom"
/>
</node>

<node display="Number of Nets" value="1870" name="number_of_nets" />

<node display="Number of Accessible Nets" value=""
name="number_of_accessible_nets" />

<node display="Number of Multi-pin Nets" value="2"
name="number_of_multi_pin_nets" >
  <classify_by display="Nets with Multiple Test Points in Top Layer"
value="0" name="Top" />
  <classify_by display="Nets with Multiple Test Points in Bottom Layer"
value="2" name="Bottom" />
</node>

<node display="Number of nets with probes" value=""
name="number_of_nets_with_probes" />

<node display="Number of single pin nets" value="929"
name="number_of_single_pin_nets" >
  <classify_by display="Nets with a Single Test Point in Top Layer"
value="0" name="Top" />
  <classify_by display="Nets with a Single Test Point in Bottom Layer"
value="929" name="Bottom" />
</node>

<node display="Number of unconnected nets" value="939" name="number_of_un-
connected_nets" >
  <classify_by display="Nets with No Test Points in Top Layer" value="937"
name="Top" />
```

```
<classify_by display="Nets with No Test Points in Bottom Layer"
value="2" name="Bottom" />
</node>

<node display="Number of Test Points" value="933"
name="number_of_test_points" >
  <classify_by display="Test Points in Top Layer" value="0" name="Top" />
  <classify_by display="Test Points in Bottom Layer" value="933"
name="Bottom" />
</node>

<node display="Pressfit Technology" value="N/A"
name="pressfit_technology" />

<node display="Smallest Pin Pitch" units="MM" value="N/A"
name="smallest_pin_pitch" />

<node display="SMD Technology" value="None" name="smd_technology" />

<node display="Total Number of SMD Pads" value="0"
name="total_number_of_smd_pads" >
  <classify_by display="SMD Pads in Top Layer" value="0" name="Top" />
  <classify_by display="SMD Pads in Bottom Layer" value="0" name="Bottom"
/>
</node>

</Assembly>

<Final description="Final QC" >

<node display="Quality Coupon Cross Section Report" value=""
name="qual_coupon_crosssection_rpt" />
<node display="Ship as" value="Single board" name="ship_as" />
<node display="Solder Resist Adhesion Test Report" value=""
name="solder_resist_adhesion_tst_rpt" />
<node display="Solderability Test Report" value=""
name="solderability_test_report" />

</Final>
</Step>
</Steps>
</metadata>
```

Metadata Schema

This is the metadata schema.

```
<?xml version="1.0" encoding="utf-8" ?>
<metadataSchema description="">

  <metadataSection internalName="Header" description="General
  Information">

    <metadataAttr internalName="buried_resistor" displayName="Buried
    Resistor" entityLevel="JOB" type="Boolean" callback="ODBAttr"
    description="Defines whether board contains buried resistors"/>
    <metadataAttr internalName="buried_capacitor" displayName="Buried
    Capacitor" entityLevel="JOB" type="Boolean" callback="ODBAttr"
    description="Defines whether board contains buried capacitors"/>
    <metadataAttr internalName="company_address" displayName="Company
    Address" entityLevel="JOB" type="Text" callback="ODBAttr"
    description="Defines company address"/>
    <metadataAttr internalName="company_name" displayName="Company Name"
    entityLevel="JOB" type="Text" callback="ODBAttr" description="Defines
    designer company name"/>
    <metadataAttr internalName="counter_bore" displayName="Counter Bore"
    entityLevel="JOB" type="Boolean" callback="ODBAttr" description="Defines
    whether job requires counter bore"/>
    <metadataAttr internalName="countersink" displayName="Counter Sink"
    entityLevel="JOB" type="Boolean" callback="ODBAttr" description="Defines
    whether job requires counter sink drilling"/>
    <metadataAttr internalName="customer_control_number"
    displayName="Customer Control Number" entityLevel="JOB" type="Text"
    callback="ODBAttr" description="Defines revision control number if
    available"/>
    <metadataAttr internalName="designer_email" displayName="Designer
    Email" entityLevel="JOB" type="Text" callback="ODBAttr"
    description="Defines designer email address"/>
    <metadataAttr internalName="designer_name" displayName="Designer Name"
    entityLevel="JOB" type="Text" callback="ODBAttr" description="Defines
    designer name"/>
    <metadataAttr internalName="designer_phone_number"
    displayName="Designer Phone Number" entityLevel="JOB" type="Text"
    callback="ODBAttr" description="Defines designer phone number"/>
    <metadataAttr internalName="direct_connections_present"
    displayName="Direct Connections Present" entityLevel="STEP"
    type="Boolean" callback="ODBAttr" description="Indicates that direct
    connections to planes are known to exist."/>
    <metadataAttr internalName="edge_connectors" displayName="Edge
    Connectors" entityLevel="JOB" type="Boolean" callback="ODBAttr"
    description="Defines whether board contains edge connectors"/>
    <metadataAttr internalName="layer_count" displayName="Layer Count"
    entityLevel="JOB" type="Integer" callback="Function" description="Defines
    number of copper layers in board"/>
    <metadataAttr internalName="layout_name" displayName="Layout Name"
    entityLevel="JOB" type="Text" callback="ODBAttr" description="Defines
    layout name of design"/>
    <metadataAttr internalName="part_x_size" displayName="Part X Size"
    entityLevel="STEP" type="float" unitsType="Distance" unitsSize="INCH_MM"
    callback="Function" description="Defines part X dimension"/>
    <metadataAttr internalName="part_y_size" displayName="Part Y Size"
    entityLevel="STEP" type="float" unitsType="Distance" unitsSize="INCH_MM"
    callback="Function" description="Defines part Y dimension"/>
    <metadataAttr internalName="pcb_part_number" displayName="PCB Part
    Number" entityLevel="JOB" type="Text" callback="ODBAttr"/>
```

```
description="Defines part number of job"/>
  <metadataAttr internalName="revision" displayName="Revision"
entityLevel="JOB" type="Text" callback="ODBAttr" description="Defines
part revision"/>
  <metadataAttr internalName="rohs_compliant" displayName="RoHS
Compliant" entityLevel="JOB" type="Boolean" callback="ODBAttr"
description="Defines whether board needs RoHS compliance"/>
  <metadataAttr internalName="ruling_ipc_spec" displayName="Ruling IPC
Spec (Class 1, 2, 3 etc.)" entityLevel="JOB" type="Option"
callback="ODBAttr" description="IPC Classification" options="Class 1,
Class 2, Class 3, ?"/>
  <metadataAttr internalName="stacked_vias_present" displayName="Stacked
Vias Present" entityLevel="STEP" type="Boolean" callback="ODBAttr"
description="Indicates if stacked vias are present"/>
</metadataSection>

<metadataSection internalName="Requirements" description="Board
Requirements">

  <metadataAttr internalName="additional_requirements"
displayName="Additional Requirements" entityLevel="JOB" type="Text"
callback="ODBAttr" description="Free text - up to 20000 characters"/>
  <metadataAttr internalName="additional_copper_lyr_require"
displayName="Additional Copper Layer Requirements" entityLevel="STEP"
type="Text" callback="ODBAttr" description="Other Requirements"/>
  <metadataAttr internalName="board_outline_tolerance_plus"
displayName="Board Outline Tolerance Plus" entityLevel="JOB" type="float"
unitsType="Distance" unitsSize="MIL_MICRON" callback="ODBAttr"
description="Defines +tolerance of board size"/>
  <metadataAttr internalName="board_outline_tolerance_minus"
displayName="Board Outline Tolerance Minus" entityLevel="JOB" type="float"
unitsType="Distance" unitsSize="MIL_MICRON" callback="ODBAttr"
description="Defines -tolerance of board size"/>
  <metadataAttr internalName="board_thickness" displayName="Board
Thickness" entityLevel="JOB" type="float" unitsType="Distance"
unitsSize="MIL_MICRON" callback="Function" description="Defines board
thickness"/>
  <metadataAttr internalName="board_thickness_tol_plus"
displayName="Board Thickness Tol Plus" entityLevel="JOB" type="float"
unitsType="Distance" unitsSize="MIL_MICRON" callback="ODBAttr"
description="Defines +tolerance of board thickness"/>
  <metadataAttr internalName="board_thickness_tol_minus"
displayName="Board Thickness Tol Minus" entityLevel="JOB" type="float"
unitsType="Distance" unitsSize="MIL_MICRON" callback="ODBAttr"
description="Defines -tolerance of board thickness"/>
  <metadataAttr internalName="board_thickness_type" displayName="Board
Thickness Type" entityLevel="JOB" type="TextWithOptions"
callback="ODBAttr" description="Defines how board thickness is measured/
specified" options="over foil, over laminate, over plated copper, over
mask on plated copper"/>
  <metadataAttr internalName="bottom_legend_color" displayName="Bottom
Legend Color" entityLevel="JOB" type="TextWithOptions" callback="ODBAttr"
description="Defines color of bottom legend" options="none , green , white
, yellow , black , blue , red"/>
  <metadataAttr internalName="bottom_soldermask_color"
displayName="Bottom Soldermask Color" entityLevel="JOB"
type="TextWithOptions" callback="ODBAttr" description="Defines color of
bottom soldermask" options="none , green , white , yellow , black , blue ,
```

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red"/>
  <metadataAttr internalName="flammability_rating_standard"
displayName="Flammability Rating Standard" entityLevel="JOB" type="Text"
callback="ODBAttr" description="Defines Flammability Rating Standard (free
text)"/>
  <metadataAttr internalName="general_pcb_standard" displayName="General
PCB Standard" entityLevel="JOB" type="Text" callback="ODBAttr"
description="Defines general PCB Standard (free text)"/>
  <metadataAttr internalName="glass_transition_temperature_tg"
displayName="Glass Transition Temperature (Tg)" entityLevel="JOB"
type="Float" unitsType="Temperature" callback="ODBAttr"
description="Degree Fahrenheit/Celcius"/>
  <metadataAttr internalName="gold_plating_thickness_min"
displayName="Gold Plating Thickness Min" entityLevel="STEP" type="float"
unitsType="Distance" unitsSize="MIL_MICRON" callback="ODBAttr"
description="Defines minimum gold plating thickness"/>
  <metadataAttr internalName="gold_plating_thickness_max"
displayName="Gold Plating Thickness Max" entityLevel="STEP" type="float"
unitsType="Distance" unitsSize="MIL_MICRON" callback="ODBAttr"
description="Defines maximum gold plating thickness"/>
  <metadataAttr internalName="hole_position_plus_tolerance"
displayName="Hole Position Plus Tolerance" entityLevel="STEP" type="float"
unitsType="Distance" unitsSize="MIL_MICRON" callback="ODBAttr"
description="Defines +tolerance for hole positions"/>
  <metadataAttr internalName="hole_position_minus_tolerance"
displayName="Hole Position Minus Tolerance" entityLevel="STEP"
type="float" unitsType="Distance" unitsSize="MIL_MICRON"
callback="ODBAttr" description="Defines -tolerance for hole positions"/>
  <metadataAttr
internalName="identify_soldermask_define_pads_that_need_to_remain_untouch
ed" displayName="Identify Soldermask Define Pads that Need to Remain
Untouched" entityLevel="STEP" type="Boolean" callback="ODBAttr"
description="Attribute indicates soldermask pads that are to remain
untouched"/>
  <metadataAttr internalName="legend_clearance_from_component_pads"
displayName="Legend Clearance from Component Pads" entityLevel="STEP"
type="float" unitsType="Distance" unitsSize="MIL_MICRON"
callback="Function" description="Defines minimum spacing between legend
and edge of copper component pads"/>
  <metadataAttr
internalName="legend_clearance_from_soldermask_clearance"
displayName="Legend Clearance from Soldermask Clearance"
entityLevel="STEP" type="float" unitsType="Distance"
unitsSize="MIL_MICRON" callback="ResultAttr" description="Defines minimum
spacing between legend and edge of soldermask clearances" arguments="min,
sm"/>
  <metadataAttr internalName="legend_clearance_from_test_points"
displayName="Legend Clearance from Test Points" entityLevel="STEP"
type="float" unitsType="Distance" unitsSize="MIL_MICRON"
callback="Function" description="Defines minimum spacing between legend
and edge of copper test pads"/>
  <metadataAttr internalName="legend_sides" displayName="Legend Sides"
entityLevel="JOB" type="Option" callback="ODBAttr" description="Defines
sides on which legend printing is to be applied"
options="none,Top,Bottom,Both"/>
  <metadataAttr internalName="lyr_to_lyr_reg_max_tolerance"
displayName="Layer to Layer Registration Max Tolerance" entityLevel="STEP"
type="float" unitsType="Distance" unitsSize="MIL_MICRON"
```

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callback="ODBAttr" description="Defines maximum tolerance for layer to
layer registration of copper layers"/>
  <metadataAttr internalName="max_bow_and_twist_of_the_pcb"
displayName="Max Bow and Twist of the PCB" entityLevel="STEP" type="float"
unitsType="Distance" unitsSize="MIL_MICRON" callback="ODBAttr"
description="Defines maximim bow&twist requirement for this part"/>
  <metadataAttr internalName="max_operating_temperature"
displayName="Max Operating Temperature" entityLevel="JOB" type="Float"
unitsType="Temperature" callback="ODBAttr" description="Degree
Fahrenheit/Celcius"/>
  <metadataAttr internalName="min_ar_blind_via" displayName="Min AR
Blind Via" entityLevel="STEP" type="float" unitsType="Distance"
unitsSize="MIL_MICRON" callback="ResultAttr" description="Defines the AR
requirement for blind via holes" arguments="min, blind_via_ar"/>
  <metadataAttr internalName="min_ar_buried_via" displayName="Min AR
Buried Via" entityLevel="STEP" type="float" unitsType="Distance"
unitsSize="MIL_MICRON" callback="ResultAttr" description="Defines min AR
requirement for buried via holes" arguments="min, buried_via_ar"/>
  <metadataAttr internalName="min_ar_pressfit_pth" displayName="Min AR
Pressfit PTH" entityLevel="STEP" type="float" unitsType="Distance"
unitsSize="MIL_MICRON" callback="Function" description="Defines min AR
requirement for Pressfit PTH"/>
  <metadataAttr internalName="min_ar_pth" displayName="Min AR PTH"
entityLevel="STEP" type="float" unitsType="Distance"
unitsSize="MIL_MICRON" callback="ResultAttr" description="Defines min AR
requirement for PTH" arguments="min, pth_ar"/>
  <metadataAttr internalName="min_ar_via" displayName="Min AR Via"
entityLevel="STEP" type="float" unitsType="Distance"
unitsSize="MIL_MICRON" callback="ResultAttr" description="Defines min AR
requirement for via holes" arguments="min, via_ar"/>
  <metadataAttr internalName="min_copper_to_board_edge" displayName="Min
Copper to Board Edge" entityLevel="STEP" type="float" unitsType="Distance"
unitsSize="MIL_MICRON" callback="ResultAttr" description="Defines minimum
spacing between copper and board edge" arguments="min, r2c"/>
  <metadataAttr internalName="min_hole_to_edge" displayName="Min Hole to
Edge" entityLevel="STEP" type="float" unitsType="Distance"
unitsSize="MIL_MICRON" callback="Function" description="Defines minimum
hole to board edge spacing"/>
  <metadataAttr internalName="min_hole_to_hole" displayName="Min Hole to
Hole" entityLevel="STEP" type="float" unitsType="Distance"
unitsSize="MIL_MICRON" callback="ResultAttr" description="Defines minimum
hole to hole spacing" arguments="min, closeh"/>
  <metadataAttr internalName="min_soldermask_clearance_for_bga_pads"
displayName="Min Soldermask Clearance for BGA Pads" entityLevel="STEP"
type="float" unitsType="Distance" unitsSize="MIL_MICRON"
callback="Function" description="Defines minimum soldermask clearance for
BGA pads"/>
  <metadataAttr internalName="min_soldermask_clearance_for_npth"
displayName="Min Soldermask Clearance for NPTH" entityLevel="STEP"
type="float" unitsType="Distance" unitsSize="MIL_MICRON"
callback="ResultAttr" description="Defines minimum soldermask clearance
for NPTH drills" arguments="min, ar_npth"/>
  <metadataAttr internalName="min_soldermask_clearance_for_pth_pads"
displayName="Min Soldermask Clearance for PTH Pads" entityLevel="STEP"
type="float" unitsType="Distance" unitsSize="MIL_MICRON"
callback="ResultAttr" description="Defines minimum soldermask clearance
for plated TH pads" arguments="min, ar_pth"/>
  <metadataAttr internalName="min_soldermask_clearance_for_smd_pads"
```



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displayName="Min Soldermask Clearance for SMD Pads" entityLevel="STEP"
type="float" unitsType="Distance" unitsSize="MIL_MICRON"
callback="ResultAttr" description="Defines minimum soldermask clearance
for SMD pads" arguments="min, ar_smd"/>
  <metadataAttr internalName="pcb_acceptability_standard"
displayName="PCB Acceptability Standard" entityLevel="JOB" type="Text"
callback="ODBAttr" description="Defines PCB Acceptability Standard (free
text)"/>
  <metadataAttr internalName="peelable_mask_side" displayName="Peelable
Mask Side" entityLevel="JOB" type="Option" callback="ODBAttr"
description="Defines whether peelable mask is to be applied, and if yes,
on which sides" options="none,Top,Bottom,Both"/>
  <metadataAttr internalName="plated_edge" displayName="Plated Edge"
entityLevel="JOB" type="Boolean" callback="ODBAttr" description="Defines
whether plating on the board edge is required"/>
  <metadataAttr internalName="plated_slots" displayName="Plated Slots"
entityLevel="JOB" type="Boolean" callback="ODBAttr" description="Defines
whether job contains plated slots"/>
  <metadataAttr internalName="qualification_performance_std"
displayName="Qualification and Performance Standard" entityLevel="JOB"
type="Text" callback="ODBAttr" description="Defines Qualification and
Performance Standard (free text)"/>
  <metadataAttr internalName="soldermask_sides" displayName="Soldermask
Sides" entityLevel="JOB" type="Option" callback="ODBAttr"
description="Defines sides on which sides soldermask is to be applied"
options="None,Top,Bottom,Both"/>
  <metadataAttr internalName="thermal_stress_requirement"
displayName="Thermal Stress Requirement" entityLevel="JOB" type="Text"
callback="ODBAttr" description="Defines thermal stress requirements for
board (free text)"/>
  <metadataAttr internalName="tolerance_standard" displayName="Tolerance
Standard" entityLevel="JOB" type="Text" callback="ODBAttr"
description="Defines standard for tolerances in board (free text)"/>
  <metadataAttr internalName="top_legend_color" displayName="Top Legend
Color" entityLevel="JOB" type="TextWithOptions" callback="ODBAttr"
description="Defines color of top legend" options="none , green , white ,
yellow , black , blue , red"/>
  <metadataAttr internalName="top_soldermask_color" displayName="Top
Soldermask Color" entityLevel="JOB" type="TextWithOptions"
callback="ODBAttr" description="Defines color of top soldermask"
options="none , green , white , yellow , black , blue , red"/>
</metadataSection>

<metadataSection internalName="Manufacturing"
description="Manufacturing Process">

  <metadataAttr internalName="allowed_remove_nfp" displayName="Allowed
to Remove non-functional Pads" entityLevel="STEP" type="Boolean"
callback="ODBAttr" description="Defines whether removing non-functional
pads is allowed"/>
  <metadataAttr internalName="barrel_cu_thickness_blind_via"
displayName="Barrel Cu Thickness Blind Via" entityLevel="STEP"
type="float" unitsType="Distance" unitsSize="MIL_MICRON"
callback="ODBAttr" description="Defines required Cu thickness in barrel of
blind via holes"/>
  <metadataAttr internalName="barrel_cu_thickness_buried_via"
displayName="Barrel Cu Thickness Buried Via" entityLevel="STEP"
type="float" unitsType="Distance" unitsSize="MIL_MICRON"
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callback="ODBAttr" description="Defines required Cu thickness in barrel of
buried via holes"/>
  <metadataAttr internalName="barrel_cu_thickness_pressfit_pth"
displayName="Barrel Cu Thickness Pressfit PTH" entityLevel="STEP"
type="float" unitsType="Distance" unitsSize="MIL_MICRON"
callback="ODBAttr" description="Defines required Cu thickness in barrel of
Pressfit holes"/>
  <metadataAttr internalName="barrel_cu_thickness_pth"
displayName="Barrel Cu Thickness PTH" entityLevel="STEP" type="float"
unitsType="Distance" unitsSize="MIL_MICRON" callback="ODBAttr"
description="Defines required Cu thickness in barrel of PTH"/>
  <metadataAttr internalName="barrel_cu_thickness_via"
displayName="Barrel Cu Thickness Via" entityLevel="STEP" type="float"
unitsType="Distance" unitsSize="MIL_MICRON" callback="ODBAttr"
description="Defines required Cu thickness in barrel of via holes"/>
  <metadataAttr internalName="circuit_copper_repairs_allowed"
displayName="PCB Circuit Copper Repairs Allowed" entityLevel="STEP"
type="TextWithOptions" callback="ODBAttr" description="Defines whether
copper repairs, to resolve spacing problems, are allowed on board"
options="Yes , Only after approval , No"/>
  <metadataAttr internalName="contour_processing_type"
displayName="Contour Processing Type" entityLevel="STEP"
type="TextWithOptions" callback="ODBAttr" description="Defines how to cut
board from panel" options="Route , V-score , Laser cutting"/>
  <metadataAttr internalName="copper_area_percent" displayName="Copper
Area Percent" entityLevel="STEP" type="float" callback="ODBAttr"
description="Percentage of copper"/>
  <metadataAttr internalName="date_stamp_format" displayName="Date Stamp
Format" entityLevel="STEP" type="text" callback="ODBAttr"
description="Defines format of date stamp"/>
  <metadataAttr internalName="date_stamp_required" displayName="Date
Stamp Required" entityLevel="STEP" type="Boolean" callback="ODBAttr"
description="Defines whether date stamp should be added on board"/>
  <metadataAttr internalName="electrical_test_required"
displayName="Electrical Test Required" entityLevel="STEP" type="Boolean"
callback="ODBAttr" description="Defines whether electrical testing of
board is required"/>
  <metadataAttr internalName="fiducial_soldermask_clearance"
displayName="Fiducial Soldermask Clearance" entityLevel="STEP"
type="float" unitsType="Distance" unitsSize="MIL_MICRON"
callback="Function" description="Defines the minimum soldermask clearance
for fiducial pads"/>
  <metadataAttr internalName="gold_plating_defined_by" displayName="Gold
Plating Defined by" entityLevel="STEP" type="Option" callback="ODBAttr"
description="Gold mask/Soldermask/NA" options="Gold mask, Solder mask, N/
A"/>
  <metadataAttr internalName="high_voltage_board" displayName="High
Voltage Board" entityLevel="STEP" type="Boolean" callback="ODBAttr"
description="Defines whether board needs to be tested for high voltage"/>
  <metadataAttr internalName="hole_breakout_allowed" displayName="Hole
Breakout Allowed" entityLevel="STEP" type="Boolean" callback="ODBAttr"
description="Defines whether hole can break out of copper pad"/>
  <metadataAttr internalName="legend_clipping_allowed"
displayName="Legend Clipping Allowed" entityLevel="STEP" type="Boolean"
callback="ODBAttr" description="Defines whether clipping of legend to
clear exposed copper from being covered by legend is allowed"/>
  <metadataAttr internalName="lot" displayName="Production Lot Number"
entityLevel="STEP" type="text" callback="ODBAttr" description="Defines
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the production lot number for a board"/>
  <metadataAttr internalName="mfg_id_stamp" displayName="Manufacturer
Identification Stamp" entityLevel="STEP" type="Boolean"
callback="ODBAttr" description="Defines whether a manufacturer
identification stamp should be added on the board"/>
  <metadataAttr internalName="min_conductor_width_inner"
displayName="Min Conductor Width Inner" entityLevel="STEP" type="float"
unitsType="Distance" unitsSize="MIL_MICRON" callback="Function"
description="Defines minimum conductor width on inner layers"/>
  <metadataAttr internalName="min_conductor_width_outer"
displayName="Min Conductor Width Outer" entityLevel="STEP" type="float"
unitsType="Distance" unitsSize="MIL_MICRON" callback="Function"
description="Defines minimum conductor width on outer layers"/>
  <metadataAttr internalName="min_copper_spacing_inner" displayName="Min
Copper Spacing Inner" entityLevel="STEP" type="float" unitsType="Distance"
unitsSize="MIL_MICRON" callback="Function" description="Defines minimum
copper spacing on inner layers"/>
  <metadataAttr internalName="min_copper_spacing_outer" displayName="Min
Copper Spacing Outer" entityLevel="STEP" type="float" unitsType="Distance"
unitsSize="MIL_MICRON" callback="Function" description="Defines minimum
copper spacing on outer layers"/>
  <metadataAttr internalName="number_of_drill_holes" displayName="Number
of Drill Holes" entityLevel="STEP" type="Integer" callback="Function"
description="Number of drill holes"/>
  <metadataAttr internalName="number_of_thru_pads" displayName="Number
of Thru Pads" entityLevel="STEP" type="Integer" callback="ResultAttr"
description="Number of through pads" arguments="num, pth"/>
  <metadataAttr internalName="number_of_tooling_holes"
displayName="Number of Tooling Holes" entityLevel="STEP" type="Integer"
callback="ResultAttr" description="Number of tooling holes"
arguments="num, tooling_holes"/>
  <metadataAttr internalName="number_of_unique_drill_sizes"
displayName="Number of Unique Drill Sizes" entityLevel="STEP"
type="Integer" callback="ResultAttr" description="Number of unique drill
sizes" arguments="num, unique_drill_size"/>
  <metadataAttr internalName="number_of_vias" displayName="Number of
Vias" entityLevel="STEP" type="Integer" callback="ResultAttr"
description="Number of vias" arguments="num, via"/>
  <metadataAttr internalName="part_number_stamp" displayName="Part
Number Stamp" entityLevel="STEP" type="Boolean" callback="ODBAttr"
description="Defines whether part number stamp should be added on board"/>
  <metadataAttr internalName="plug_vias" displayName="Plug Vias"
entityLevel="STEP" type="Boolean" callback="ODBAttr" description="Defines
whether vias should be plugged"/>
  <metadataAttr internalName="print_et_test_stamp_on_board"
displayName="Print ET Test Stamp on Board" entityLevel="STEP"
type="Boolean" callback="ODBAttr" description="Defines whether required to
print ET stamp on the board"/>
  <metadataAttr internalName="smallest_drill_size" displayName="Smallest
Drill Size" entityLevel="STEP" type="Float" unitsType="Distance"
unitsSize="MIL_MICRON" callback="Function" description="Smallest drill
size"/>
  <metadataAttr internalName="smallest_trace_width"
displayName="Smallest Trace Width" entityLevel="STEP" type="Float"
unitsType="Distance" unitsSize="MIL_MICRON" callback="Function"
description="Smallest trace width"/>
  <metadataAttr internalName="smallest_via_diameter"
displayName="Smallest Via Diameter" entityLevel="STEP" type="Float"
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unitsType="Distance" unitsSize="MIL_MICRON" callback="Function"
description="Smallest via diameter"/>
  <metadataAttr internalName="surface_finish_contact_fingers"
displayName="Surface Finish Contact Fingers" entityLevel="STEP"
type="TextWithOptions" callback="ODBAttr" description="Defines surface
finish for contact fingers" options="HASL , Lead-Free HASL , OSP (Entek) ,
ENIG , Deep Gold , Wirebondable Gold , Bare Cu , Immersion Silver , White
Tin , Other"/>
  <metadataAttr internalName="surface_finish_pads" displayName="Surface
Finish Pads" entityLevel="STEP" type="TextWithOptions" callback="ODBAttr"
description="Defines surface finish for exposed pads" options="HASL ,
Lead-Free HASL , OSP (Entek) , ENIG , Deep Gold , Wirebondable Gold , Bare
Cu , Immersion Silver , White Tin , Other"/>
  <metadataAttr internalName="teardrop_allowed_on_inner"
displayName="Teardrop Addition Allowed on Inner" entityLevel="STEP"
type="Boolean" callback="ODBAttr" description="Defines whether adding
teardrops on inner copper layers is allowed"/>
  <metadataAttr internalName="teardrop_allowed_on_outer"
displayName="Teardrop Addition Allowed on Outer" entityLevel="STEP"
type="Boolean" callback="ODBAttr" description="Defines whether adding
teardrops on outer copper layers is allowed"/>
  <metadataAttr internalName="thieving_restrictions_on_inner"
displayName="Thieving Restrictions on Inner" entityLevel="STEP"
type="Text" callback="ODBAttr" description="Defines restrictions for
thieving patterns on inner layers (free text)"/>
  <metadataAttr internalName="thieving_restrictions_on_outer"
displayName="Thieving Restrictions on Outer" entityLevel="STEP"
type="Text" callback="ODBAttr" description="Defines restrictions for
thieving patterns on outer layers (free text)"/>
  <metadataAttr internalName="ul_code_stamp" displayName="UL Code Stamp"
entityLevel="STEP" type="Boolean" callback="ODBAttr" description="Defines
whether UL Code stamp should be added on board"/>
  <metadataAttr internalName="unique_serial_nr_stamp"
displayName="Unique Serial NR Stamp" entityLevel="STEP" type="Boolean"
callback="ODBAttr" description="Defines whether a unique serial nr stamp
should be added on board"/>
  <metadataAttr internalName="via_tenting" displayName="Via Tenting"
entityLevel="STEP" type="Boolean" callback="ODBAttr" description="Defines
whether via tenting can be used"/>
  <metadataAttr internalName="via_treatments" displayName="Via
Treatments" entityLevel="STEP" type="TextWithOptions" callback="ODBAttr"
description="Determine which via treatment should be applied" options="Via
Fill - Conductive, Via Fill - Non-conductive, Via Fill - Copper Plated,
Via Fill - Soldermask Hole Filled, Via Capped, Clearance - Standard
Soldermask Clearance, Dry Film Via Tenting, Soldermask Defined -
Soldermask over Via"/>
</metadataSection>

<metadataSection internalName="Assembly" description="Assembly">

  <metadataAttr internalName="cad_package_analysis" displayName="Cad
Package Analysis" entityLevel="STEP" type="Integer" callback="Collective"
description="CAD package analysis: Number of unique cells per side and
total associated pin count and pin pitch"/>
  <metadataAttr internalName="complete_test_required"
displayName="Complete Test Required" entityLevel="STEP" type="Boolean"
callback="ODBAttr" description="Defines whether a test including barrel
testing is required"/>
```

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<metadataAttr internalName="component_count" displayName="Components
per Step" entityLevel="STEP" type="Integer" callback="Collective"
description="Total component count&#xA;Classified by layer (top, bottom,
etc),&#xA;Then classified by technology (SMD, Thru, etc)"/>
<metadataAttr internalName="number_of_fiducials" displayName="Number
of Fiducials" entityLevel="STEP" type="Integer" callback="Collective"
description="Number of top and bottom fiducials"/>
<metadataAttr internalName="number_of_nets" displayName="Number of
Nets" entityLevel="STEP" type="Integer" callback="Function"
description="Number of nets"/>
<metadataAttr internalName="number_of_accessible_nets"
displayName="Number of Accessible Nets" entityLevel="STEP" type="Integer"
callback="ODBAttr" description="Number of accessible nets"/>
<metadataAttr internalName="number_of_multi_pin_nets"
displayName="Number of Multi-pin Nets" entityLevel="STEP" type="Integer"
callback="Collective" description="Number of multi-pin nets"/>
<metadataAttr internalName="number_of_nets_with_probes"
displayName="Number of nets with probes" entityLevel="STEP" type="Integer"
callback="ODBAttr" description="Number of nets with probes"/>
<metadataAttr internalName="number_of_single_pin_nets"
displayName="Number of single pin nets" entityLevel="STEP" type="Integer"
callback="Collective" description="Number of single pin nets"/>
<metadataAttr internalName="number_of_un-connected_nets"
displayName="Number of unconnected nets" entityLevel="STEP" type="Integer"
callback="Collective" description="Number of unconnected nets"/>
<metadataAttr internalName="number_of_test_points" displayName="Number
of Test Points" entityLevel="STEP" type="Integer" callback="Collective"
description="Defines the number of test points (net ends) on top and
bottom sides"/>
<metadataAttr internalName="pressfit_technology" displayName="Pressfit
Technology" entityLevel="STEP" type="Boolean" callback="Function"
description="Defines whether Pressfit technology should be used on this
board."/>
<metadataAttr internalName="smallest_pin_pitch" displayName="Smallest
Pin Pitch" entityLevel="STEP" type="Float" unitsType="Distance"
unitsSize="MIL_MICRON" callback="ResultAttr" description="Smallest pin
pitch" arguments="min, c_pitch"/>
<metadataAttr internalName="smd_technology" displayName="SMD
Technology" entityLevel="STEP" type="Option" callback="Function"
description="Defines number of sides that have SMD technology."
options="Single sided, Double sided, None"/>
<metadataAttr internalName="total_number_of_smd_pads"
displayName="Total Number of SMD Pads" entityLevel="STEP" type="Integer"
callback="Collective" description="Total number of SMD pads, classified by
side"/>
</metadataSection>

<metadataSection internalName="Final" description="Final QC">

  <metadataAttr internalName="qual_coupon_crosssection_rpt"
  displayName="Quality Coupon Cross Section Report" entityLevel="STEP"
  type="Text" callback="ODBAttr" description="Defines type of quality coupon
  cross section report (free text)"/>
  <metadataAttr internalName="ship_as" displayName="Ship as"
  entityLevel="STEP" type="Option" callback="ODBAttr" description="Single
  board / assembly panel" options="Single board, Assembly panel"/>
  <metadataAttr internalName="solder_resist_adhesion_tst_rpt"
  displayName="Solder Resist Adhesion Test Report" entityLevel="STEP"
```

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type="Text" callback="ODBAttr" description="Defines type of solder resist
adhesion test report (free text)"/>
  <metadataAttr internalName="solderability_test_report"
displayName="Solderability Test Report" entityLevel="STEP" type="Text"
callback="ODBAttr" description="Defines type of solderability test report
(free text)"/>
</metadataSection>
</metadataSchema>
```

Appendix E

Stackup Schema

This appendix describes the elements, their related sub-elements, and the relevant attributes of the stackup file. Each element's description contains the following sections: parent element, hierarchical diagram, minimum and maximum numbers of occurrences, description of the attributes, and a list of sub-elements known as children. The full schema file is provided.

Elements or attributes enclosed in solid lines are mandatory. Those enclosed in dotted lines are optional. Plus or minus indicate the collapsed or expanded state of the element or attribute. The display of a numerical range under an element or attribute indicates its accepted range of values. Some elements are designated as `simpleType`—they specify constraints and information about the values of attributes or text-only elements. Other elements are `complexType`—an XML element that contains other elements or attributes.

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StackupFile/EdaData/Specs/Spec/Material/Conductor	342
StackupFile/EdaData/Specs/Spec/Material/Conductor/Properties	344
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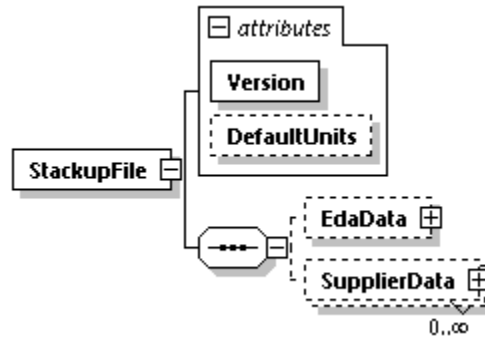
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Stackup Schema File	455

StackupFile

The base of ODB++ stackup content that includes material, impedance, and a design-based stackup requirement, followed by any number of supplier-based stackup solutions.

Diagram



Attributes

Name	Type	Use	Default	Description
Version	xs:string	required		Defines the ODB++ Version of the <i>stackup.xml</i> file
DefaultUnits	UnitsType	optional	MIL	Carries the dimension Units value whenever referenced by the schema

Children

- “[StackupFile/EdaData](#)” on page 332
- “[StackupFile/SupplierData](#)” on page 395

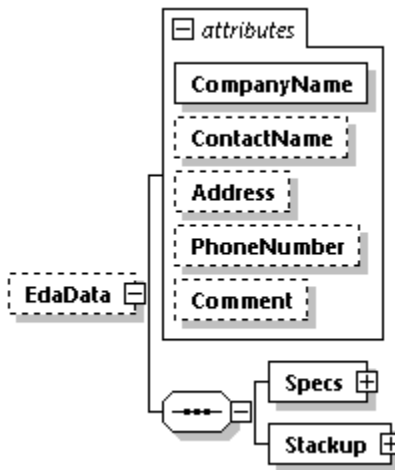
StackupFile/EdaData

Contains all the stackup-required content as delivered by the design source. This may be a generic section containing basic material requirements and impedance definition, or a full set of stackup definitions provided by a stackup software solution. This section is the basis for all stackup definitions and must not be altered in any way by stackup suppliers.

Parent

“[StackupFile](#)” on page 331

Diagram



Occurrence

0-1

Attributes

Name	Type	Use	Default	Description
CompanyName	xs:string	required		The name of the design company of the originating stackup
ContactName	xs:string	optional		The name of the contact of the originating stackup
Address	xs:string	optional		The postal address of the design company of the originating stackup

Name	Type	Use	Default	Description
PhoneNumber	xs:string	optional		The phone number of the design company of the originating stackup
Comment	xs:string	optional		Open comment from the design company of the originating stackup

Children

- “[StackupFile/EdaData/Specs](#)” on page 334
- “[StackupFile/EdaData/Stackup](#)” on page 385

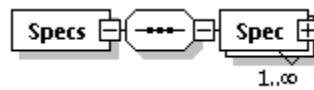
StackupFile/EdaData/Specs

Contains a list of material specifications and impedance requirements for the stack design. Each specification is represented by an instance of the Spec element.

Parent

“[StackupFile/EdaData](#)” on page 332

Diagram



Occurrence

1

Children

“[StackupFile/EdaData/Specs/Spec](#)” on page 335

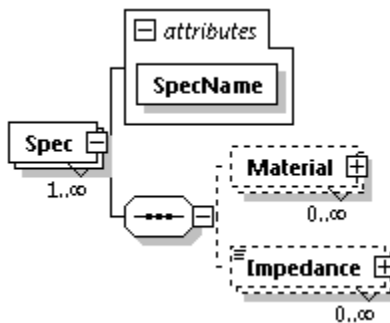
StackupFile/EdaData/Specs/Spec

An individual specification defining the collection of materials and impedance requirements. The Spec is selected through the use of the SpecName attribute.

Parent

“[StackupFile/EdaData/Specs](#)” on page 334

Diagram



Occurrence

1-n

Attributes

Name	Type	Use	Default	Description
SpecName	xs:string	required		The name referencing the given Spec

Children

- “[StackupFile/EdaData/Specs/Spec/Material](#)” on page 336
- “[StackupFile/EdaData/Specs/Spec/Impedance](#)” on page 348

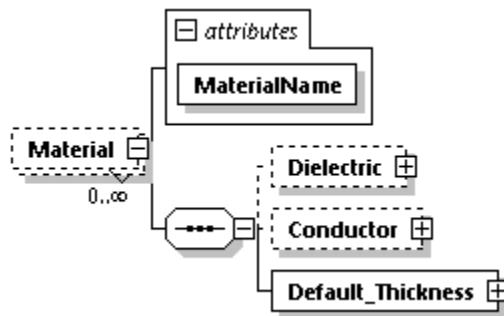
StackupFile/EdaData/Specs/Spec/Material

A Material specification defining a specific material, dielectric or conductor. The Material is selected through the use of the MaterialName attribute.

Parent

“[StackupFile/EdaData/Specs/Spec](#)” on page 335

Diagram



Occurrence

0-n

Attributes

Name	Type	Use	Default	Description
MaterialName	xs:string	required		The name referencing the given Material

Children

- “[StackupFile/EdaData/Specs/Spec/Material/Dielectric](#)” on page 337
- “[StackupFile/EdaData/Specs/Spec/Material/Conductor](#)” on page 342
- “[StackupFile/EdaData/Specs/Spec/Material/Default_Thickness](#)” on page 347

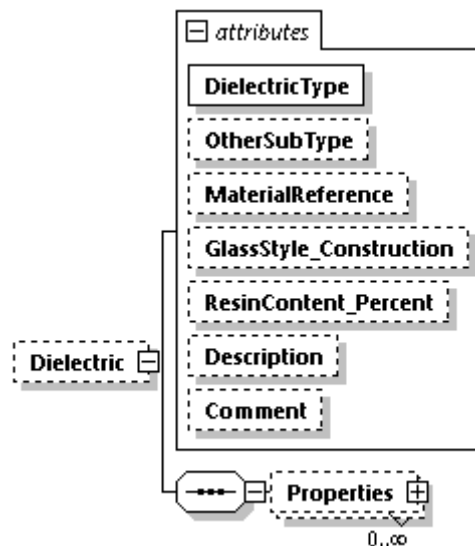
StackupFile/EdaData/Specs/Spec/Material/Dielectric

The definition of a specific piece of dielectric material.

Parent

“[StackupFile/EdaData/Specs/Spec/Material](#)” on page 336

Diagram



Occurrence

0-1

Attributes

Name	Type	Use	Default	Description
DielectricType	DielectricType	required		Defines the generic type of dielectric materials as prepreg, core, or other
OtherSubType	OtherType	optional		A list of material definitions that are most often used when DielectricType is OTHER
MaterialReference	xs:string	optional		Free text providing the material supplier's reference name

Name	Type	Use	Default	Description
GlassStyle_Construction	xs:string	optional		Free text describing the Prepreg glass or Core construction
ResinContent_Percent	xs:double	optional		The percentage of resin in the dielectric material
Description	xs:string	optional		Open description of the dielectric material
Comment	xs:string	optional		Open comment on the dielectric material

Children

“[StackupFile/EdaData/Specs/Spec/Material/Dielectric/Properties](#)” on page 339

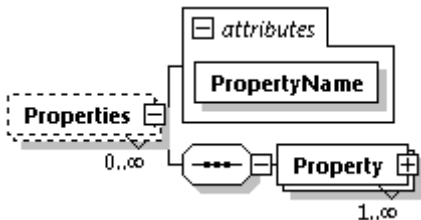
StackupFile/EdaData/Specs/Spec/Material/Dielectric/Properties

Contains a list of Properties related to the material behavior. Material’s electrical characteristics are influenced by the frequency of the impedance net. The Property is selected through the use of the PropertyName attribute.

Parent

“[StackupFile/EdaData/Specs/Spec/Material/Dielectric](#)” on page 337

Diagram



Occurrence

0-n

Attributes

Name	Type	Use	Default	Description
PropertyName	xs:string	required		The name referencing the given set of Properties

Children

“[StackupFile/EdaData/Specs/Spec/Material/Dielectric/Properties/Property](#)” on page 340

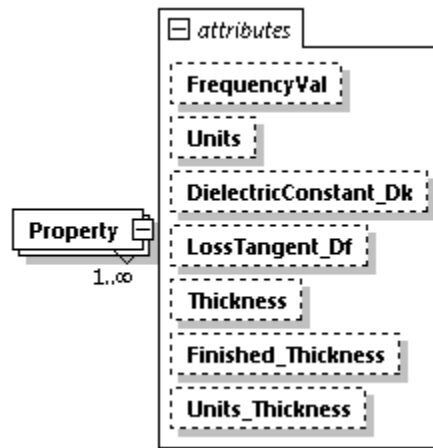
StackupFile/EdaData/Specs/Spec/Material/Dielectric/Properties/Property

A specific property and the related material characteristics.

Parent

“[StackupFile/EdaData/Specs/Spec/Material/Dielectric/Properties](#)” on page 339

Diagram



Occurrence

1-n

Attributes

Name	Type	Use	Default	Description
FrequencyVal	xs:double	optional		The value of the single frequency.
Units	UnitsType	optional	GHz	The unit of the FrequencyVal frequency.
DielectricConstant_Dk	xs:double	optional		The Dielectric Constant (DK) at the specified FrequencyVal frequency.
LossTangent_Df	xs:double	optional		The Loss Tangent (Df) at the specified FrequencyVal frequency.

Name	Type	Use	Default	Description
Thickness	xs:double	optional		The overriding thickness of the dielectric material. The unit of measure is governed by StackupFile -> DefaultUnits, which is by default MIL.
Finished_Thickness	xs:double	optional		The overriding finished thickness of the dielectric material. The unit of measure is governed by StackupFile -> DefaultUnits, which is by default MIL.
Units_Thickness	UnitsType	optional	MIL	The unit of measure used by the Thickness and Finished_Thickness attributes. This unit is governed by StackupFile -> DefaultUnits.

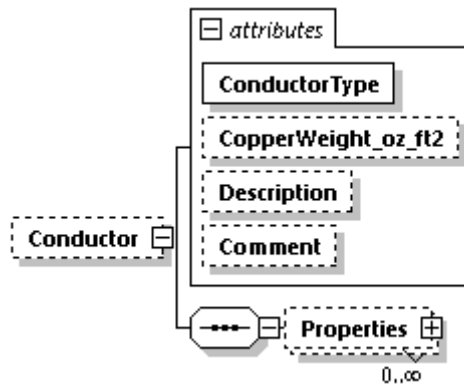
StackupFile/EdaData/Specs/Spec/Material/Conductor

The definition of a specific piece of conductive material.

Parent

“[StackupFile/EdaData/Specs/Spec/Material](#)” on page 336

Diagram



Occurrence

0-1

Attributes

Name	Type	Use	Default	Description
ConductorType	ConductorType	required		The type of conductor (COPPER or OTHER).
CopperWeight_oz_ft2	xs:double	optional		Mainly, a historical means to specify copper thickness by using the value of the Thickness attribute located under Material.
Description	xs:string	optional		Open description of the conductive material.
Comment	xs:string	optional		Open comment on the conductive material.

Children

“[StackupFile/EdaData/Specs/Spec/Material/Conductor/Properties](#)” on page 344

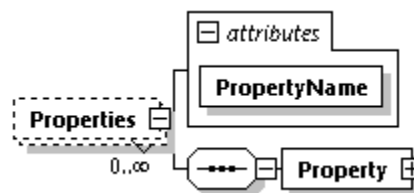
StackupFile/EdaData/Specs/Spec/Material/Conductor/Properties

Contains a list of Properties related to the material behavior. The Property is selected through the use of the PropertyName attribute.

Parent

[“StackupFile/EdaData/Specs/Spec/Material/Conductor”](#) on page 342

Diagram



Occurrence

0-n

Attributes

Name	Type	Use	Default	Description
PropertyName	xs:string	required		The name referencing the given set of Properties

Children

[“StackupFile/EdaData/Specs/Spec/Material/Conductor/Properties/Property”](#) on page 345

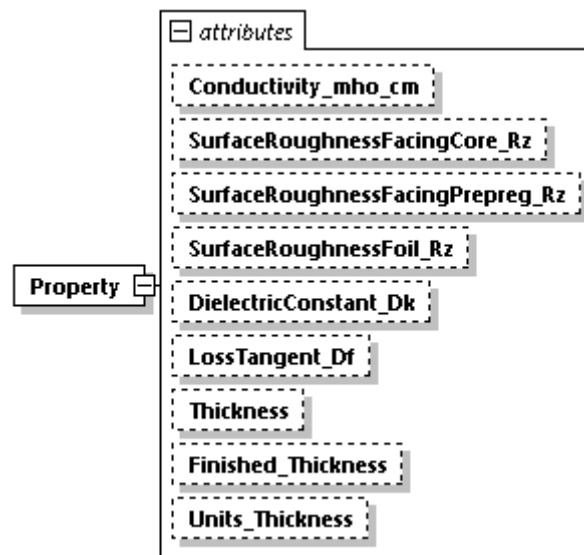
StackupFile/EdaData/Specs/Spec/Material/Conductor/Properties/Property

A specific property and the related material characteristics.

Parent

“[StackupFile/EdaData/Specs/Spec/Material/Conductor/Properties](#)” on page 344

Diagram



Occurrence

1

Attributes

Name	Type	Use	Default	Description
Conductivity_mho_cm	xs:double	optional		The Conductivity of copper measured in MHO/CM.
SurfaceRoughnessFacingCore_Rz	xs:double	optional		The surface roughness of copper facing the core, measured in Rz.
SurfaceRoughnessFacingPrepreg_Rz	xs:double	optional		The surface roughness of copper facing the prepreg, measured in Rz.

Name	Type	Use	Default	Description
SurfaceRoughnessFoil_Rz	xs:double	optional		The surface roughness of the copper foil or sheet materials measured in Rz.
DielectricConstant_Dk	xs:double	optional		The Dielectric Constant (DK) contributed to the resin during the lamination process.
LossTangent_Df	xs:double	optional		The Loss Tangent (Df) contributed to the resin during the lamination process.
Thickness	xs:double	optional		The overriding thickness of the conductor material. The unit of measure is governed by StackupFile -> DefaultUnits, which is by default MIL.
Finished_Thickness	xs:double	optional		The overriding finished thickness of the conductor material. The unit of measure is governed by StackupFile -> DefaultUnits, which is by default MIL.
Units_Thickness	UnitsType	optional	ML	The unit of measure used by the Thickness and Finished_Thickness attributes. This unit is governed by StackupFile -> DefaultUnits.

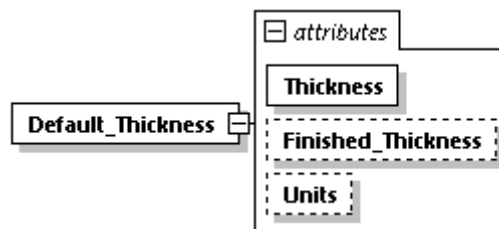
StackupFile/EdaData/Specs/Spec/Material/Default_Thickness

The thickness definition for the supplier-delivered dielectric or conductor material.

Parent

“[StackupFile/SupplierData/Specs/Spec/Material](#)” on page 399

Diagram



Occurrence

1

Attributes

Name	Type	Use	Default	Description
Thickness	xs:double	required		The default thickness of the dielectric or conductor material. The unit of measure is governed by StackupFile -> DefaultUnits, which is by default MIL.
Finished_Thickness	xs:double	optional		The default finished thickness of the dielectric or conductor material. The unit of measure is governed by StackupFile -> DefaultUnits, which is by default MIL.
Units	xs:double	optional	MIL	The unit of measure used by the Thickness and Finished_Thickness attributes. This unit is governed by StackupFile -> DefaultUnits.

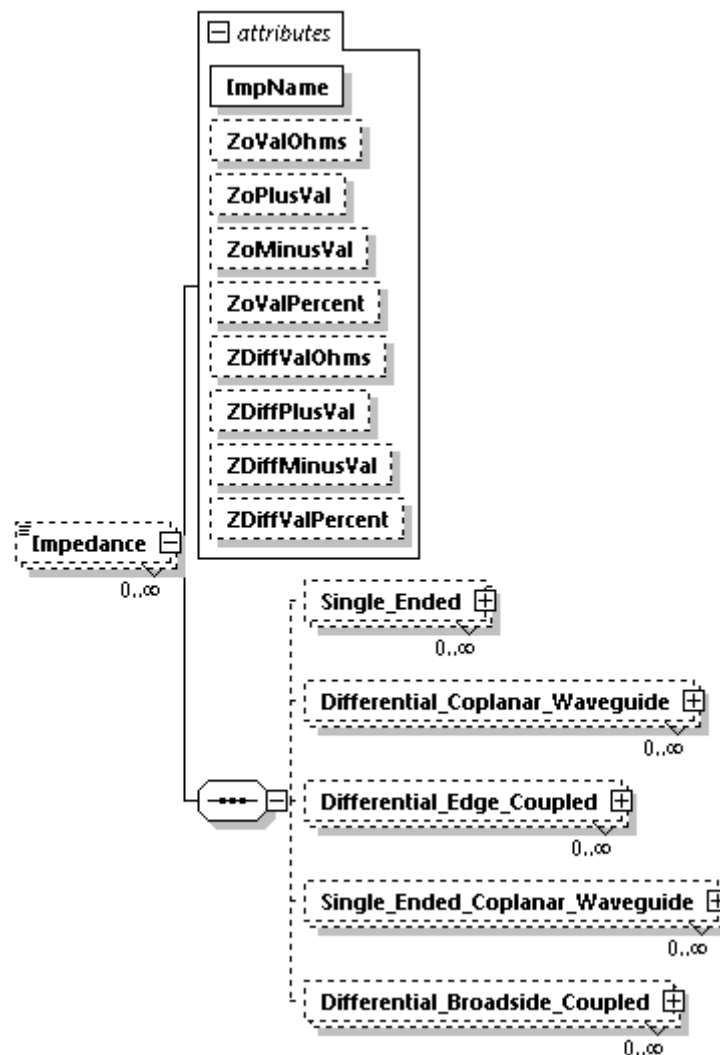
StackupFile/EdaData/Specs/Spec/Impedance

An Impedance specification defining the general impedance goal and physical characteristics. The Impedance is selected through the use of the ImplName attribute.

Parent

“[StackupFile/EdaData/Specs/Spec](#)” on page 335

Diagram



Occurrence

0-n

Attributes

Name	Type	Use	Default	Description
ImpName	xs:string	required		The name referencing the given Impedance.
ZoValOhms	xs:double	optional		Single-ended impedance target value in Ohms.
ZoPlusVal	xs:double	optional		A positive value representing the plus value to add to the target single-ended impedance value ZoValOhms (tolerance). The use of ZoPlusVal is determined by the ZoValPercent value.
ZoMinusVal	xs:double	optional		A positive value representing the plus value to subtract from the target single-ended impedance value ZoValOhms (tolerance). The use of ZoPMinusVal is determined by the ZoValPercent value.
ZoValPercent	xs:boolean	optional	true	Single-ended tolerance definition: true — a percentage of ZoValOhms false — an absolute value to add or subtract from ZoValOhms
ZDiffValOhms	xs:double	optional		Differential impedance target value in Ohms.
ZDiffPlusVal	xs:double	optional		A positive value representing the plus value to add to the target differential impedance value ZDiffValOhms (tolerance). The use of ZDiffPlusVal is determined by the ZDiffValPercent value.
ZDiffMinusVal	xs:double	optional		A positive value representing the plus value to subtract from the target differential impedance value ZDiffValOhms (tolerance). The use of ZDiffMinusVal is determined by the ZDiffValPercent value.

Name	Type	Use	Default	Description
ZDiffValPercent	xs:boolean	optional	true	Differential tolerance definition: true — a percentage of ZDiffValOhms false — an absolute value to add or subtract from ZDiffValOhms

Children

- “[StackupFile/EdaData/Specs/Spec/Impedance/Single_Ended](#)” on page 351
- “[StackupFile/EdaData/Specs/Spec/Impedance/Differential_Coplanar_Waveguide](#)” on page 356
- “[StackupFile/EdaData/Specs/Spec/Impedance/Differential_Edge_Coupled](#)” on page 365
- “[StackupFile/EdaData/Specs/Spec/Impedance/Single_Ended_Coplanar_Waveguide](#)” on page 371
- “[StackupFile/EdaData/Specs/Spec/Impedance/Differential_Broadside_Coupled](#)” on page 379

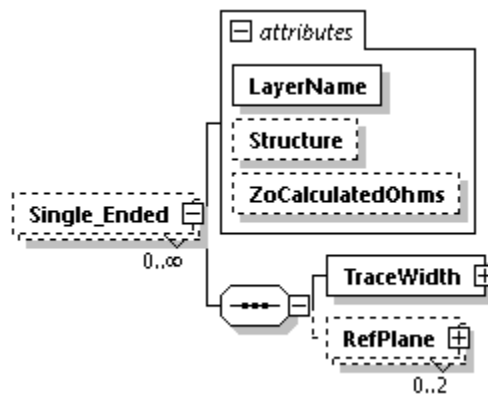
StackupFile/EdaData/Specs/Spec/Impedance/Single_Ended

A representation of the single-ended impedance requirement.

Parent

“[StackupFile/EdaData/Specs/Spec/Impedance](#)” on page 348

Diagram



Occurrence

0-n

Attributes

Name	Type	Use	Default	Description
LayerName	xs:string	required		The Layer name referencing the given Impedance Type.
Structure	Structure	optional		The impedance structure definition in the areas of stripline, microstrip, or Coplanar waveguide.
ZoCalculatedOhms	xs:double	optional		If the design source has an impedance simulator, this attribute contains the calculated result for the given single-ended impedance instance.

Children

- [“StackupFile/EdaData/Specs/Spec/Impedance/Single_Ended/TraceWidth”](#) on page 353
- [“StackupFile/EdaData/Specs/Spec/Impedance/Single_Ended/RefPlane”](#) on page 355

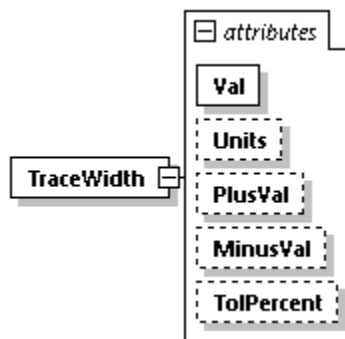
StackupFile/EdaData/Specs/Spec/Impedance/Single_Ended/TraceWidth

Contains the desired trace width to use for the target impedance.

Parent

“[StackupFile/EdaData/Specs/Spec/Impedance/Single_Ended](#)” on page 351

Diagram



Occurrence

1

Attributes

Name	Type	Use	Default	Description
Val	xs:double	required		The target trace width of the related conductor.
Units	UnitsType	optional	MIL	The unit of measure used by the Val attribute.
PlusVal	xs:double	optional		A positive value representing the plus tolerance value to add to the target trace value in the Val attribute.
MinusVal	xs:double	optional		A positive value representing the negative tolerance value to subtract from the target trace value in the Val attribute.

Name	Type	Use	Default	Description
TolPercent	xs:boolean	optional	false	Trace width tolerance definition: true — a percentage of the Val attribute value false — an absolute value to add or subtract from the Val attribute value

StackupFile/EdaData/Specs/Spec/Impedance/Single_Ended/RefPlane

Contains the list of layers that represent the reference planes in impedance calculation.

Parent

“[StackupFile/EdaData/Specs/Spec/Impedance/Single_Ended](#)” on page 351

Diagram



Occurrence

0-2

Attributes

Name	Type	Use	Default	Description
RefLayerName	xs:string	required		The LayerName value of the layer found under StackupFile -> EdaData -> Stackup -> Group -> Layer. This value represents a reference plane used during the impedance calculation.

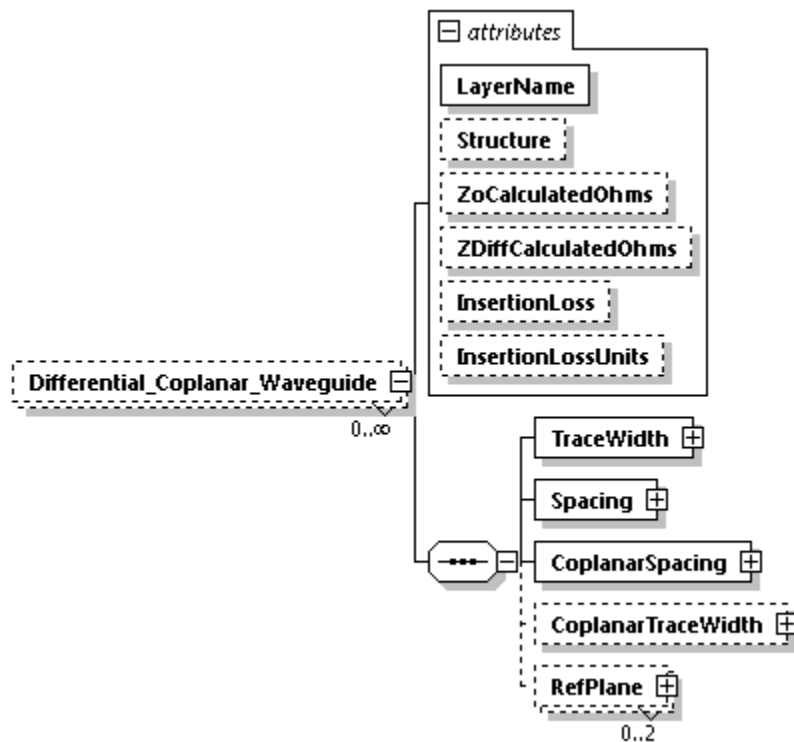
StackupFile/EdaData/Specs/Spec/Impedance/Differential_Coplanar_Waveguide

A representation of the differential Coplanar waveguide impedance requirement.

Parent

“[StackupFile/EdaData/Specs/Spec/Impedance](#)” on page 348

Diagram



Occurrence

0-n

Attributes

Name	Type	Use	Default	Description
LayerName	xs:string	required		The Layer name referencing the given Impedance Type.

Name	Type	Use	Default	Description
Structure	Structure	optional		The impedance structure definition in the areas of stripline, microstrip, or Coplanar waveguide.
ZoCalculatedOhms	xs:double	optional		If the design source has an impedance simulator, this attribute contains the calculated result for the given single-ended impedance instance.
ZDiffCalculatedOhms	xs:double	optional		If the design source has an impedance simulator, this attribute contains the calculated result for the given differential impedance instance.
InsertionLoss	xs:double	optional		The resulting loss of single power.
InsertionLossUnits	UnitsType	optional	DB/INCH	Units for InsertionLoss.

Children

- [“StackupFile/EdaData/Specs/Spec/Impedance/Differential_Coplanar_Waveguide/TraceWidth”](#) on page 358
- [“StackupFile/EdaData/Specs/Spec/Impedance/Differential_Coplanar_Waveguide/Spacing”](#) on page 360
- [“StackupFile/EdaData/Specs/Spec/Impedance/Differential_Coplanar_Waveguide/CoplanarSpacing”](#) on page 361
- [“StackupFile/EdaData/Specs/Spec/Impedance/Differential_Coplanar_Waveguide/CoplanarTraceWidth”](#) on page 362
- [“StackupFile/EdaData/Specs/Spec/Impedance/Differential_Coplanar_Waveguide/RefPlane”](#) on page 364

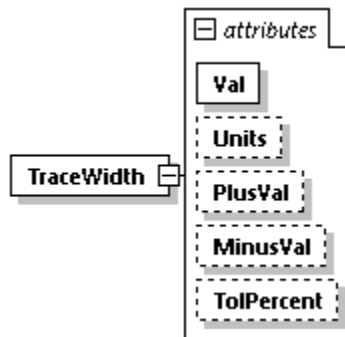
StackupFile/EdaData/Specs/Spec/Impedance/Differential_Coplanar_Waveguide/TraceWidth

Contains the desired trace width to use for the target impedance.

Parent

“[StackupFile/EdaData/Specs/Spec/Impedance/Differential_Coplanar_Waveguide](#)” on page 356

Diagram



Occurrence

1

Attributes

Name	Type	Use	Default	Description
Val	xs:double	required		The target trace width of the related conductor.
Units	UnitsType	optional	MIL	The unit of measure used by the Val attribute.
PlusVal	xs:double	optional		A positive value representing the plus tolerance value to add to the target trace width value in the Val attribute.
MinusVal	xs:double	optional		A positive value representing the negative tolerance value to subtract from the target trace width value in the Val attribute.

Name	Type	Use	Default	Description
TolPercent	xs:boolean	optional	false	Trace width tolerance definition: true — a percentage of the Val attribute value false — an absolute value to add or subtract from the Val attribute value

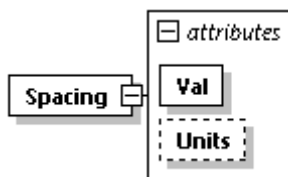
StackupFile/EdaData/Specs/Spec/Impedance/Differential_Coplanar_Waveguide/Spacing

Contains the desired spacing between copper for the target impedance.

Parent

“[StackupFile/EdaData/Specs/Spec/Impedance/Differential_Coplanar_Waveguide](#)” on page 356

Diagram



Occurrence

1

Attributes

Name	Type	Use	Default	Description
Val	xs:double	required		The target spacing for the related conductor
Units	UnitsType	optional	MIL	The unit of measure used by the Val attribute

StackupFile/EdaData/Specs/Spec/Impedance/Differential_Coplanar_Waveguide/CoplanarSpacing

Contains the desired Coplanar spacing to use for the target impedance.

Parent

“[StackupFile/EdaData/Specs/Spec/Impedance/Differential_Coplanar_Waveguide](#)” on page 356

Diagram



Occurrence

1

Attributes

Name	Type	Use	Default	Description
Val	xs:double	required		The target Coplanar spacing for the related conductor
Units	UnitsType	optional	MIL	The unit of measure used by the Val attribute

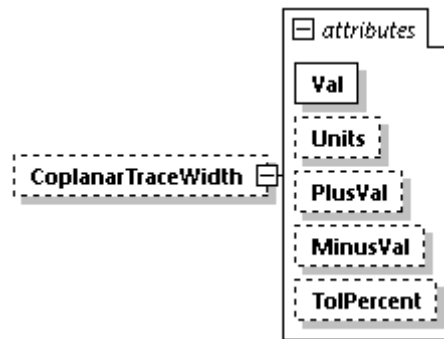
StackupFile/EdaData/Specs/Spec/Impedance/Differential_Coplanar_Waveguide/CoplanarTraceWidth

Contains the desired Coplanar trace width to use for the target impedance. When using reference planes, this element is not to be defined.

Parent

“[StackupFile/EdaData/Specs/Spec/Impedance/Differential_Coplanar_Waveguide](#)” on page 356

Diagram



Occurrence

0-1

Attributes

Name	Type	Use	Default	Description
Val	xs:double	required		The target Coplanar trace width of the related conductor.
Units	UnitsType	optional	MIL	The unit of measure used by the Val attribute.
PlusVal	xs:double	optional		A positive value representing the plus tolerance value to add to the target Coplanar trace width value in the Val attribute.

Name	Type	Use	Default	Description
MinusVal	xs:double	optional		A positive value representing the negative tolerance value to subtract from the target Coplanar trace width value in the Val attribute.
TolPercent	xs:boolean	optional	false	Trace width tolerance definition: true — a percentage of the Val attribute value false — an absolute value to add or subtract from the Val attribute value

StackupFile/EdaData/Specs/Spec/Impedance/Differential_Coplanar_Waveguide/RefPlane

Contains the list of layers that represent the reference planes in impedance calculation.

Parent

“[StackupFile/EdaData/Specs/Spec/Impedance/Differential_Coplanar_Waveguide](#)” on page 356

Diagram



Occurrence

0-2

Attributes

Name	Type	Use	Default	Description
RefLayerName	xs:string	required		The LayerName value of the layer found under StackupFile -> EdaData -> Stackup -> Group -> Layer. This value represents a reference plane used during the impedance calculation.

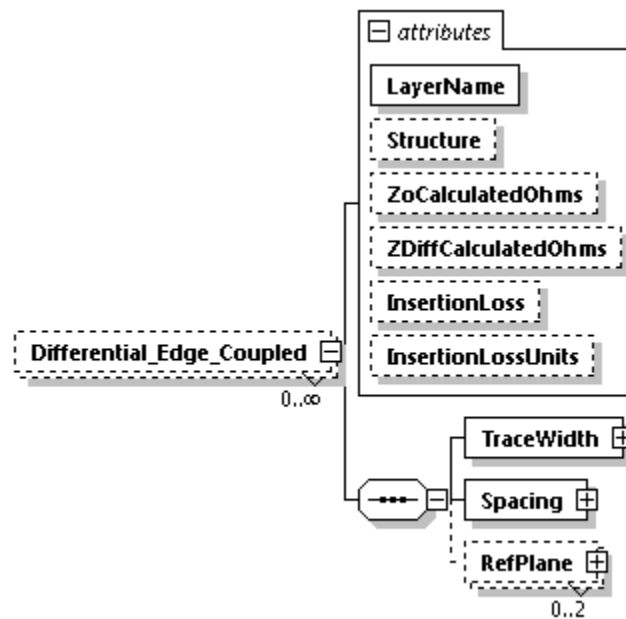
StackupFile/EdaData/Specs/Spec/Impedance/Differential_Edge_Coupled

A representation of the edge-coupled differential impedance requirement.

Parent

“[StackupFile/EdaData/Specs/Spec/Impedance](#)” on page 348

Diagram



Occurrence

0-n

Attributes

Name	Type	Use	Default	Description
LayerName	xs:string	required		The Layer name referencing the given Impedance Type.
Structure	Structure	optional		The impedance structure definition in the areas of stripline, microstrip, or Coplanar waveguide.

Name	Type	Use	Default	Description
ZoCalculatedOhms	xs:double	optional		If the design source has an impedance simulator, this attribute contains the calculated result for the given single-ended impedance instance.
ZDiffCalculateOhms	xs:double	optional		If the design source has an impedance simulator, this attribute contains the calculated result for the given differential impedance instance.
InsertionLoss	xs:double	optional		The resulting loss of single power.
InsertionLossUnits	InsertionLossType	optional	DB/INCH	Units for InsertionLoss.

Children

- [“StackupFile/EdaData/Specs/Spec/Impedance/Differential_Edge_Coupled/TraceWidth”](#) on page 367
- [“StackupFile/EdaData/Specs/Spec/Impedance/Differential_Edge_Coupled/Spacing”](#) on page 369
- [“StackupFile/EdaData/Specs/Spec/Impedance/Differential_Edge_Coupled/RefPlane”](#) on page 370

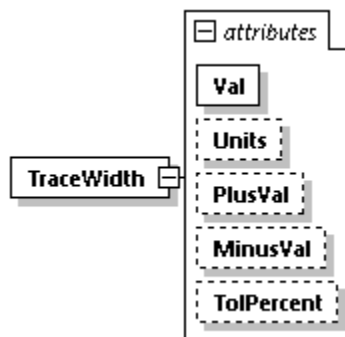
StackupFile/EdaData/Specs/Spec/Impedance/Differential_Edge_Coupled/TraceWidth

Contains the desired trace width to use for the target impedance.

Parent

“[StackupFile/EdaData/Specs/Spec/Impedance/Differential_Edge_Coupled](#)” on page 365

Diagram



Occurrence

1

Attributes

Name	Type	Use	Default	Description
Val	xs:double	required		The target trace width of the related conductor.
Units	UnitsType	optional	MIL	The unit of measure used by the Val attribute.
PlusVal	xs:double	optional		A positive value representing the plus tolerance value to add to the target trace width value in the Val attribute.
MinusVal	xs:double	optional		A positive value representing the negative tolerance value to subtract from the target trace width value in the Val attribute.

Name	Type	Use	Default	Description
TolPercent	xs:boolean	optional	false	Trace width tolerance definition: true — a percentage of the Val attribute value false — an absolute value to add or subtract from the Val attribute value

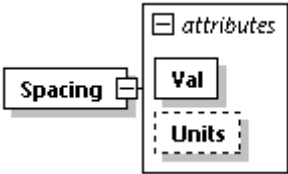
StackupFile/EdaData/Specs/Spec/Impedance/Differential_Edge_Coupled/Spacing

Contains the desired spacing between copper for the target impedance.

Parent

“[StackupFile/EdaData/Specs/Spec/Impedance/Differential_Edge_Coupled](#)” on page 365

Diagram



Occurrence

1

Attributes

Name	Type	Use	Default	Description
Val	xs:double	required		The target spacing for the related conductor.
Units	UnitsType	optional	MIL	The unit of measure used by the Val attribute.

StackupFile/EdaData/Specs/Spec/Impedance/Differential_Edge_Coupled/RefPlane

Contains the list of layers that represent the reference planes in impedance calculation.

Parent

“[StackupFile/EdaData/Specs/Spec/Impedance/Differential_Edge_Coupled](#)” on page 365

Diagram



Occurrence

0-2

Attributes

Name	Type	Use	Default	Description
RefLayerName	xs:string	required		The LayerName value of the layer found under StackupFile -> EdaData -> Stackup -> Group -> Layer. This value represents a reference plane used during the impedance calculation.

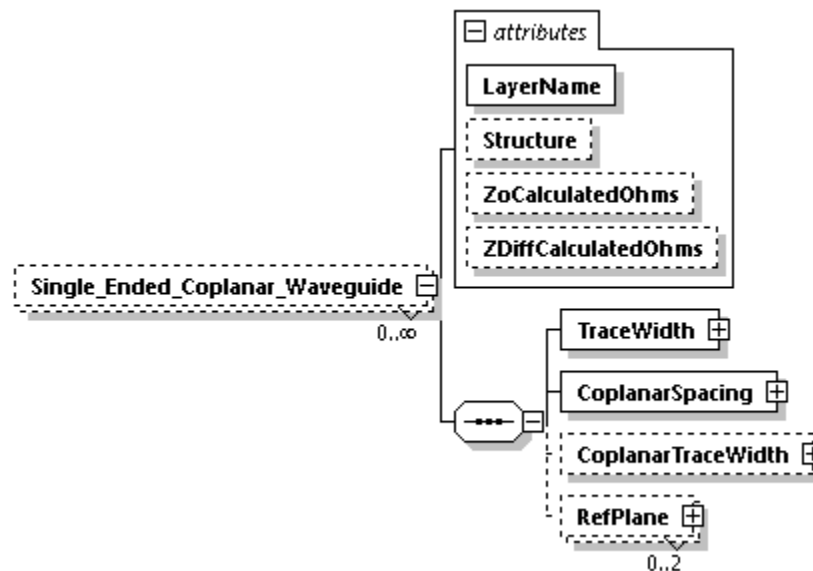
StackupFile/EdaData/Specs/Spec/Impedance/Single_Ended_Coplanar_Waveguide

A representation of the Coplanar single-ended waveguide impedance requirement.

Parent

“[StackupFile/EdaData/Specs/Spec/Impedance](#)” on page 348

Diagram



Occurrence

0-n

Attributes

Name	Type	Use	Default	Description
LayerName	xs:string	required		The Layer name referencing the given Impedance Type.
Structure	Structure	optional		The impedance structure definition in the areas of stripline, microstrip, or Coplanar waveguide.

Name	Type	Use	Default	Description
ZoCalculatedOhms	xs:double	optional		If the design source has an impedance simulator, this attribute contains the calculated result for the given single-ended impedance instance.
ZDiffCalculatedOhms	xs:double	optional		If the design source has an impedance simulator, this attribute contains the calculated result for the given differential impedance instance.

Children

- [“StackupFile/EdaData/Specs/Spec/Impedance/Single_Ended_Coplanar_Waveguide/CoplanarTraceWidth”](#) on page 376
- [“StackupFile/EdaData/Specs/Spec/Impedance/Single_Ended_Coplanar_Waveguide/CoplanarSpacing”](#) on page 375
- [“StackupFile/EdaData/Specs/Spec/Impedance/Single_Ended_Coplanar_Waveguide/TraceWidth”](#) on page 373
- [“StackupFile/EdaData/Specs/Spec/Impedance/Single_Ended_Coplanar_Waveguide/RefPlane”](#) on page 378

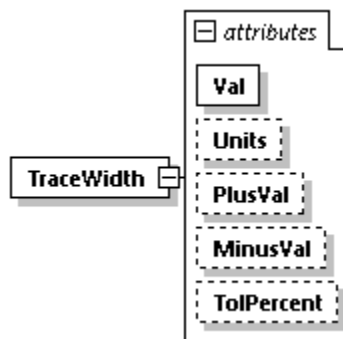
StackupFile/EdaData/Specs/Spec/Impedance/Single_Ended_Coplanar_Waveguide/TraceWidth

Contains the desired trace width to use for the target impedance.

Parent

“[StackupFile/EdaData/Specs/Spec/Impedance/Single_Ended_Coplanar_Waveguide](#)” on page 371

Diagram



Occurrence

1

Attributes

Name	Type	Use	Default	Description
Val	xs:double	required		The target trace width of the related conductor.
Units	UnitsType	optional	MIL	The unit of measure used by the Val attribute.
PlusVal	xs:double	optional		A positive value representing the plus tolerance value to add to the target trace value in the Val attribute.
MinusVal	xs:double	optional		A positive value representing the negative tolerance value to subtract from the target trace value in the Val attribute.

Name	Type	Use	Default	Description
TolPercent	xs:boolean	optional	false	Trace width tolerance definition: true — a percentage of the Val attribute value false — an absolute value to add or subtract from the Val attribute value

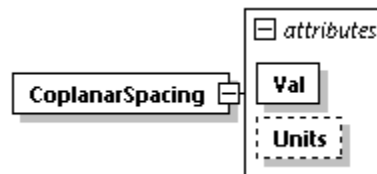
StackupFile/EdaData/Specs/Spec/Impedance/Single_Ended_Coplanar_Waveguide/CoplanarSpacing

Contains the desired spacing between copper for the target impedance.

Parent

“[StackupFile/EdaData/Specs/Spec/Impedance/Single_Ended_Coplanar_Waveguide](#)” on page 371

Diagram



Occurrence

1

Attributes

Name	Type	Use	Default	Description
Val	xs:double	required		The target Coplanar spacing for the related conductor.
Units	UnitsType	optional	MIL	The unit of measure used by the Val attribute.

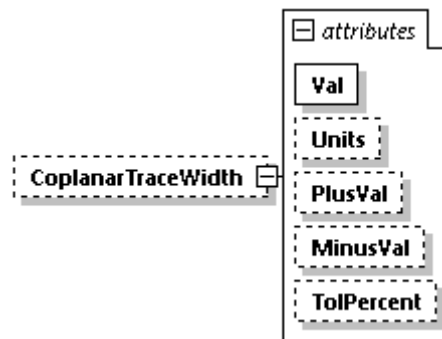
StackupFile/EdaData/Specs/Spec/Impedance/Single_Ended_Coplanar_Waveguide/CoplanarTraceWidth

Contains the desired coplanar trace width to use for the target impedance. When using reference planes, this element is not to be defined.

Parent

“[StackupFile/EdaData/Specs/Spec/Impedance/Single_Ended_Coplanar_Waveguide](#)” on page 371

Diagram



Occurrence

0-1

Attributes

Name	Type	Use	Default	Description
Val	xs:double	required		The target Coplanar trace width of the related conductor.
Units	UnitsType	optional	MIL	The unit of measure used by the Val attribute.
PlusVal	xs:double	optional		A positive value representing the plus tolerance value to add to the target Coplanar trace width value in the Val attribute.

Name	Type	Use	Default	Description
MinusVal	xs:double	optional		A positive value representing the negative tolerance value to subtract from the target Coplanar trace width value in the Val attribute.
TolPercent	xs:boolean	optional	false	Trace width tolerance definition: true — a percentage of the Val attribute value false — an absolute value to add or subtract from the Val attribute value

StackupFile/EdaData/Specs/Spec/Impedance/Single_Ended_Coplanar_Waveguide/RefPlane

Contains the list of layers that represent the reference planes in impedance calculation.

Parent

“[StackupFile/EdaData/Specs/Spec/Impedance/Single_Ended_Coplanar_Waveguide](#)” on page 371

Diagram



Occurrence

0-2

Attributes

Name	Type	Use	Default	Description
RefLayerName	xs:string	required		The LayerName value of the layer found under StackupFile -> EdaData -> Stackup -> Group -> Layer. This value represents a reference plane used during the impedance calculation.

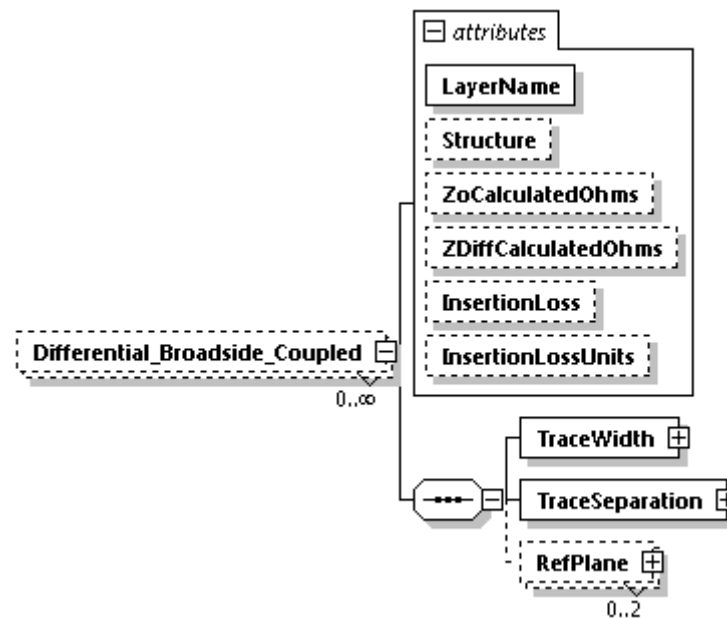
StackupFile/EdaData/Specs/Spec/Impedance/Differential_Broadside_Coupled

A representation of the broadside-coupled differential impedance requirement.

Parent

“[StackupFile/EdaData/Specs/Spec/Impedance](#)” on page 348

Diagram



Occurrence

0-n

Attributes

Name	Type	Use	Default	Description
LayerName	xs:string	required		The Layer name referencing the given Impedance Type
Structure	Structure	optional		The impedance structure definition in the areas of stripline, microstrip, or Coplanar waveguide

Name	Type	Use	Default	Description
ZoCalculatedOhm	xs:double	optional		The calculated result for this single-ended impedance instance
ZDiffCalculateOhms	xs:double	optional		The calculated result for this differential impedance instance
InsertionLoss	xs:double	optional		The resulting loss of single power
InsertionLossUnits	InsertionLossType	optional	DB/INCH	Units for InsertionLoss

Children

- “[StackupFile/EdaData/Specs/Spec/Impedance/Differential_Broadside_Coupled/TraceWidth](#)” on page 381
- “[StackupFile/EdaData/Specs/Spec/Impedance/Differential_Broadside_Coupled/TraceSeparation](#)” on page 383
- “[StackupFile/EdaData/Specs/Spec/Impedance/Differential_Broadside_Coupled/RefPlane](#)” on page 384

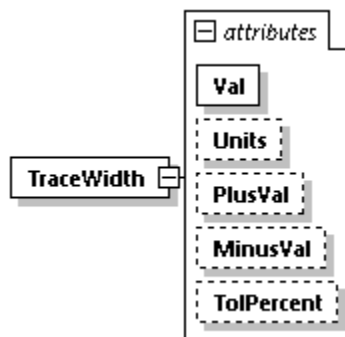
StackupFile/EdaData/Specs/Spec/Impedance/Differential_Broadside_Coupled/TraceWidth

Contains the desired trace width to use for the target impedance.

Parent

“[StackupFile/EdaData/Specs/Spec/Impedance/Differential_Broadside_Coupled](#)” on page 379

Diagram



Occurrence

1

Attributes

Name	Type	Use	Default	Description
Val	xs:double	required		The target trace width of the related conductor.
Units	UnitsType	optional	MIL	The unit of measure used by the Val attribute.
PlusVal	xs:double	optional		A positive value representing the plus tolerance value to add to the target trace width value in the Val attribute.
MinusVal	xs:double	optional		A positive value representing the negative tolerance value to subtract from the target trace width value in the Val attribute.

Name	Type	Use	Default	Description
TolPercent	xs:boolean	optional	false	Trace width tolerance definition: true — a percentage of the Val attribute value false — an absolute value to add or subtract from the Val attribute value

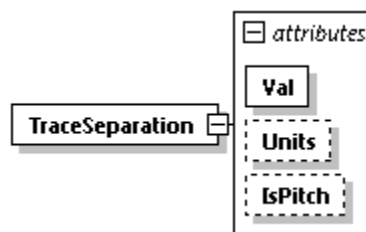
StackupFile/EdaData/Specs/Spec/Impedance/Differential_Broadside_Coupled/TraceSeparation

Contains the desired distance between the related conductors.

Parent

“[StackupFile/EdaData/Specs/Spec/Impedance/Differential_Broadside_Coupled](#)” on page 379

Diagram



Occurrence

1

Attributes

Name	Type	Use	Default	Description
Val	xs:double	required		The target copper separation value for the related conductors
Units	UnitsType	optional	MIL	The unit of measure used by the Val attribute
IsPitch	xs:boolean	optional	true	Trace Separation definition: true — the spacing between the conductors is measured from center line to center line, or pitch false — the spacing between the conductors is measured from edge to edge

StackupFile/EdaData/Specs/Spec/Impedance/Differential_Broadside_Coupled/RefPlane

Contains the list of layers that represent the reference planes in impedance calculation.

Parent

“[StackupFile/EdaData/Specs/Spec/Impedance/Differential_Broadside_Coupled](#)” on page 379

Diagram



Occurrence

0-2

Attributes

Name	Type	Use	Default	Description
RefLayerName	xs:string	required		The LayerName value of the layer found under StackupFile -> EdaData -> Stackup -> Group -> Layer. This value represents a reference plane used during the impedance calculation.

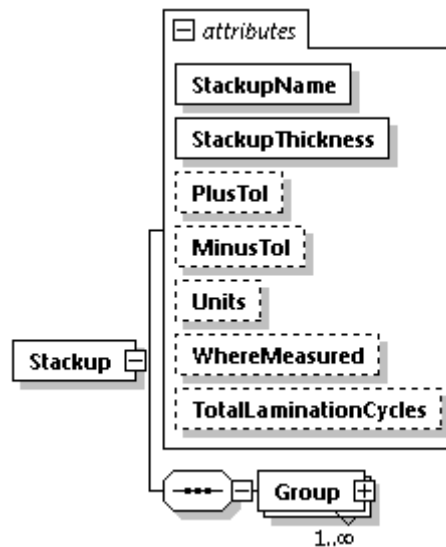
StackupFile/EdaData/Stackup

Contains the stackup representation as delivered by the design source.

Parent

“[StackupFile/EdaData](#)” on page 332

Diagram



Occurrence

1

Attributes

Name	Type	Use	Default	Description
StackupName	xs:string	required		The name referencing the given Stackup.
StackupThickness	xs:double	required		The target board thickness in units defined in the Units attribute.
PlusTol	xs:double	optional		A positive value representing the plus value to add to the target stackup thickness the StackupThickness.

Name	Type	Use	Default	Description
MinusTol	xs:double	optional		A positive value representing the negative value to subtract from the target stackup thickness StackupThickness.
Units	UnitsType	optional	MIL	The unit of measure used by the StackupThickness, PlusTol, and MinusTol attributes. This unit of measure is governed by StackupFile -> DefaultUnits.
WhereMeasured	WhereMeasured	optional	METAL	An enumerated value indicating where to measure the StackupThickness value.
TotalLaminationCycles	xs:integer	optional		The total number of lamination cycles required to complete the booking process.

Children

[“StackupFile/EdaData/Stackup/Group”](#) on page 387

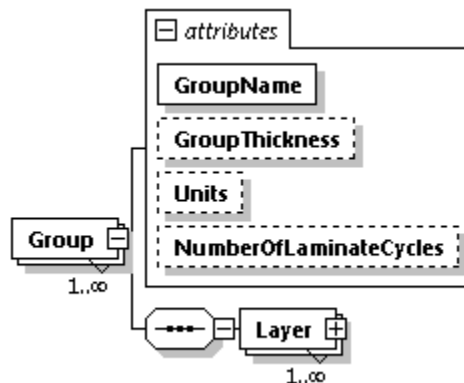
StackupFile/EdaData/Stackup/Group

A stackup is created from Groups. A Group is a collection of Materials in which conductor materials are tied to copper layers of the design. Each series is represented from the top of the stack to the bottom.

Parent

“[StackupFile/EdaData/Stackup](#)” on page 385

Diagram



Occurrence

1-n

Attributes

Name	Type	Use	Default	Description
GroupName	xs:string	required		The name referencing the given Group.
GroupThickness	xs:double	optional		The total thickness for the group of layers, in units defined in the Units attribute.
Units	UnitsType	optional	MIL	The unit of measure used by the GroupThickness attribute. This unit is governed by StackupFile -> DefaultUnits.
NumberOfLaminateCycles	xs:integer	optional		The total number of lamination cycles to subject the layer group, from the beginning to the end of the booking process.

Children

[“StackupFile/EdaData/Stackup/Group/Layer”](#) on page 389

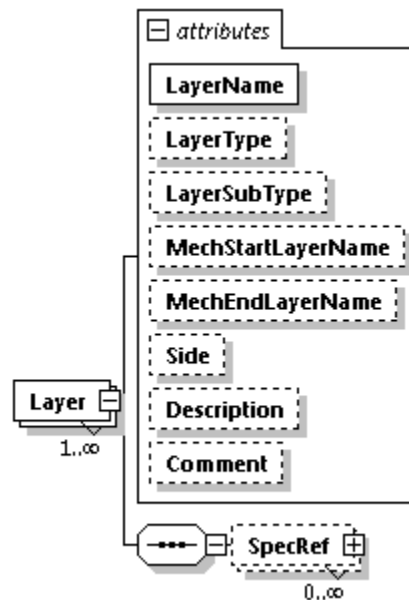
StackupFile/EdaData/Stackup/Group/Layer

A Layer definition within the Group.

Parent

“[StackupFile/EdaData/Stackup/Group](#)” on page 387

Diagram



Occurrence

1-n

Attributes

Name	Type	Use	Default	Description
LayerName	xs:string	required		The name of layer used within the design.
LayerType	LayerType	optional	DOCUMENT	An enumerated list of layer types representing the purpose of the layer.

Name	Type	Use	Default	Description
LayerSubType	SideType	optional		An enumerated list of layer subtypes that refine the LayerType value. For example, a LayerType DRILL with a SubType BACKDRILL.
MechStartLayerName	xs:string	optional		If LayerType has the value of DRILL or ROUT, this attribute contains the name of the initial layer where the material is mechanically penetrated.
MechEndLayerName	xs:string	optional		If LayerType has the value of DRILL or ROUT, this attribute contains the name of the final layer where the material is mechanically penetrated.
Side	SideType	optional	NONE	An enumerated list of a values declaring the relative position of the layer within the stackup.
Description	xs:string	optional		Open description from the design company of the originating layer.
Comment	xs:string	optional		Open comment from the design company of the originating layer.

Children

“[StackupFile/EdaData/Stackup/Group/Layer/SpecRef](#)” on page 391

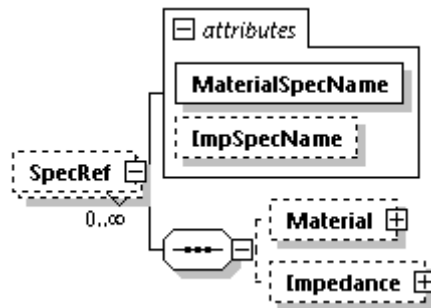
StackupFile/EdaData/Stackup/Group/Layer/SpecRef

The list of Material and Impedance Specs, and conductor requirements for a layer.

Parent

“[StackupFile/EdaData/Stackup/Group/Layer](#)” on page 389

Diagram



Occurrence

0-n

Attributes

Name	Type	Use	Default	Description
MaterialSpecName	xs:string	required		The name referencing the selected Material Spec
ImpSpecName	xs:string	optional		The name referencing the selected Impedance Spec

Children

- “[StackupFile/EdaData/Stackup/Group/Layer/SpecRef/Material](#)” on page 392
- “[StackupFile/EdaData/Stackup/Group/Layer/SpecRef/Impedance](#)” on page 394

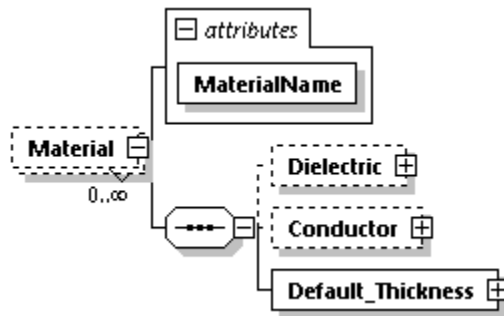
StackupFile/EdaData/Stackup/Group/Layer/SpecRef/Material

Defines the Material requirements for a layer.

Parent

[“StackupFile/EdaData/Stackup/Group/Layer/SpecRef”](#) on page 391

Diagram



Occurrence

0-1

Attributes

Name	Type	Use	Default	Description
MaterialName	xs:string	required		The name referencing the designated Material within the referenced SpecName.
PropertyName	xs:string	optional		The name referencing the designated Properties within the referenced Material. If only one Property is defined, then this Property is considered the default, and the existence of the attribute FrequencyVal is not required.

Name	Type	Use	Default	Description
FrequencyVal	xs:double	optional		<p>The frequency of the signal on the net.</p> <p>This attribute can reference additional material content when referenced into PropertyName.</p> <p>If only one Property is defined, then it is considered the default, and the existence of this attribute is not required.</p>
CopperAreaPercent	xs:double	optional		<p>Percentage calculated by dividing the copper area of the layer by the total area of the layer laminate.</p>
TraceWidthTop	xs:double	optional		<p>After the etching process, traces have a trapezoidal shape, with the top of the copper narrower than the bottom. This attribute contains the width of the top of a trace located on the design.</p> <p>If not present, then the value of TraceWidthBottom is used.</p> <p>The unit of measure is governed by StackupFile -> DefaultUnits, which is by default MIL.</p>
TraceWidthBottom	xs:double	optional		<p>After the etching process, traces have a trapezoidal shape, with the top of the copper narrower than the bottom. This attribute contains the width of the bottom of a trace located on the design.</p> <p>For conductor layer types, this value is required.</p> <p>The unit of measure is governed by StackupFile -> DefaultUnits, which is by default MIL.</p>
Units_TraceWidth	UnitsType	optional	MIL	<p>The unit of measure used by the the TraceWidthTop and TraceWidthBottom attributes.</p>

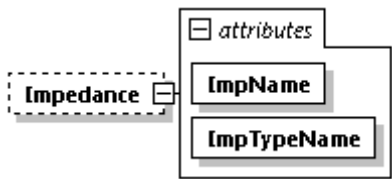
StackupFile/EdaData/Stackup/Group/Layer/SpecRef/Impedance

Defines the impedance requirements for a layer.

Parent

“[StackupFile/EdaData/Stackup/Group/Layer/SpecRef](#)” on page 391

Diagram



Occurrence

0-1

Attributes

Name	Type	Use	Default	Description
ImpName	xs:string	required		The name referencing the designated Impedance
ImpTypeName	ImpedanceType	required		The type of impedance to use within the designated Impedance

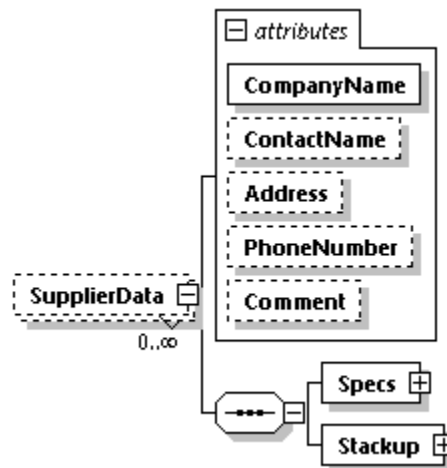
StackupFile/SupplierData

Represents instances of the manufacturing stackup, each with the required content determined by the supplier. This section should contain a full stackup defining the final materials and impedance calculation based on the material of use.

Parent

“[StackupFile](#)” on page 331

Diagram



Occurrence

0-n

Attributes

Name	Type	Use	Default	Description
CompanyName	xs:string	required		The name of the supplier of the manufacturing stackup
ContactName	xs:string	optional		The name of the contact of the originating stackup
Address	xs:string	optional		The postal address of the supplier of the manufacturing stackup
PnoneNumber	xs:string	optional		The phone number of the supplier of the manufacturing stackup
Comment	xs:string	optional		Open comment from the supplier of the manufacturing stackup

Children

- “[StackupFile/SupplierData/Specs](#)” on page 397
- “[StackupFile/SupplierData/Stackup](#)” on page 447

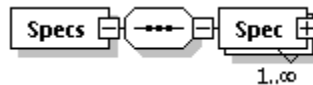
StackupFile/SupplierData/Specs

Contains a list of material specifications and impedance requirements for the stack design. Each specification is represented by an instance of the Spec element.

Parent

“[StackupFile/SupplierData](#)” on page 395

Diagram



Occurrence

1

Children

“[StackupFile/SupplierData/Specs/Spec](#)” on page 398

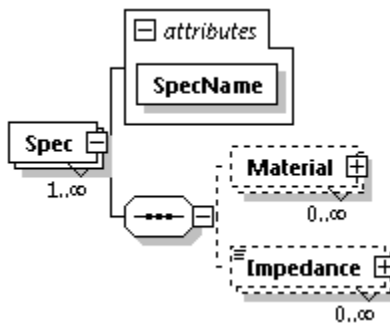
StackupFile/SupplierData/Specs/Spec

An individual specification defining the collection of materials and impedance requirements. The Spec is selected through the use of the SpecName attribute.

Parent

“[StackupFile/SupplierData/Specs](#)” on page 397

Diagram



Occurrence

1-n

Attributes

Name	Type	Use	Default	Description
SpecName	xs:string	required		The name referencing the given Spec

Children

- “[StackupFile/SupplierData/Specs/Spec/Material](#)” on page 399
- “[StackupFile/SupplierData/Specs/Spec/Impedance](#)” on page 411

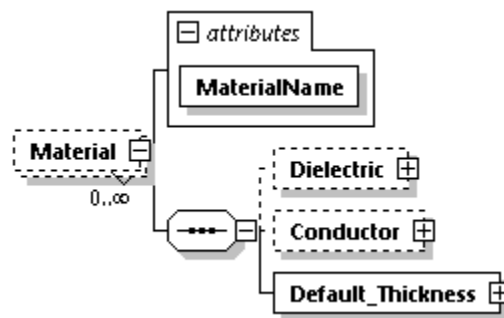
StackupFile/SupplierData/Specs/Spec/Material

A Material specification defining a specific material, dielectric or conductor. The Material is selected through the use of the MaterialName attribute.

Parent

“[StackupFile/SupplierData/Specs/Spec](#)” on page 398

Diagram



Occurrence

0-n

Attributes

Name	Type	Use	Default	Description
MaterialName	xs:string	required		The name referencing the given Material

Children

- “[StackupFile/SupplierData/Specs/Spec/Material/Dielectric](#)” on page 400
- “[StackupFile/SupplierData/Specs/Spec/Material/Conductor](#)” on page 405
- “[StackupFile/SupplierData/Specs/Spec/Material/Default_Thickness](#)” on page 410

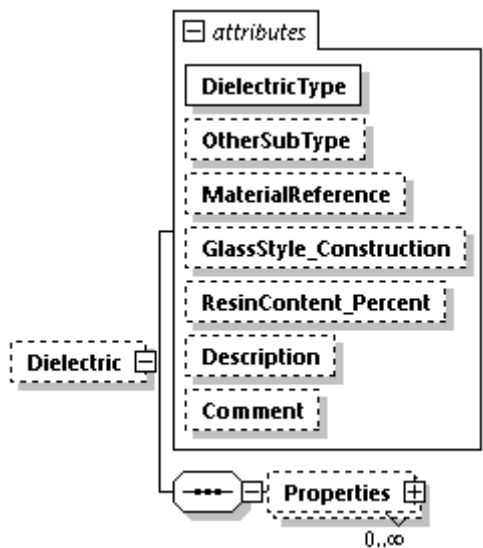
StackupFile/SupplierData/Specs/Spec/Material/Dielectric

The definition of a specific piece of dielectric material.

Parent

“[StackupFile/SupplierData/Specs/Spec/Material](#)” on page 399

Diagram



Occurrence

0-1

Attributes

Name	Type	Use	Default	Description
DielectricType	DielectricType e	required		Defines the generic type of dielectric materials as prepreg, core, or other
OtherSubType	OtherType	optional		A list of material definitions that are most often used when DielectricType is OTHER
MaterialReference	xs:string	optional		Free text providing the material supplier’s reference name

Name	Type	Use	Default	Description
GlassStyle_Construction	xs:string	optional		Free text describing the Prepreg glass or Core construction
ResinContent_Percent	xs:double	optional		The percentage of resin in the dielectric material
Description	xs:string	optional		Open description of the dielectric material
Comment	xs:string	optional		Open comment on the dielectric material

Children

“[StackupFile/SupplierData/Specs/Spec/Material/Dielectric/Properties](#)” on page 402

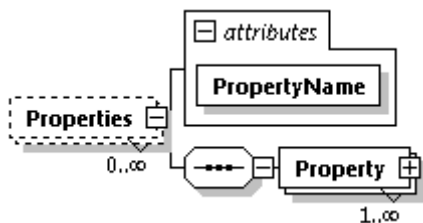
StackupFile/SupplierData/Specs/Spec/Material/Dielectric/Dielectric/Properties

Contains a list of Frequencies related to the material behavior. Material’s electrical characteristics are influenced by the frequency of the impedance net. The Frequency is selected through the use of the FrequencyName attribute.

Parent

“[StackupFile/SupplierData/Specs/Spec/Material/Dielectric](#)” on page 400

Diagram



Occurrence

0-n

Attributes

Name	Type	Use	Default	Description
PropertyName	xs:string	required		The name referencing the given Frequency

Children

“[StackupFile/SupplierData/Specs/Spec/Material/Dielectric/Properties/Property](#)” on page 403

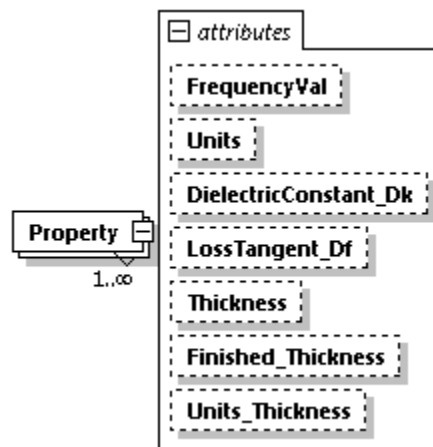
StackupFile/SupplierData/Specs/Spec/Material/Dielectric/Properties/Property

A specific frequency and the related material characteristics.

Parent

“[StackupFile/SupplierData/Specs/Spec/Material/Dielectric/Properties](#)” on page 402

Diagram



Occurrence

1-n

Attributes

Name	Type	Use	Default	Description
FrequencyVal	xs:double	optional		The value of the single frequency.
Units	UnitsType	optional	GHz	The unit of the FrequencyVal frequency.
DielectricConstant_Dk	xs:double	optional		The Dielectric Constant (DK) at the specified FrequencyVal frequency.
LossTangent_Df	xs:double	optional		The Loss Tangent (Df) at the specified FrequencyVal frequency.

Name	Type	Use	Default	Description
Thickness	xs:double	optional		The overriding thickness of the dielectric material. The unit of measure is governed by StackupFile -> DefaultUnits, which is by default MIL.
Finished_Thickness	xs:double	optional		The overriding finished thickness of the dielectric material. The unit of measure is governed by StackupFile -> DefaultUnits, which is by default MIL.
Units_Thickness	UnitsType	optional	MIL	The unit of measure used by the Thickness and Finished_Thickness attributes. This unit is governed by StackupFile -> DefaultUnits.

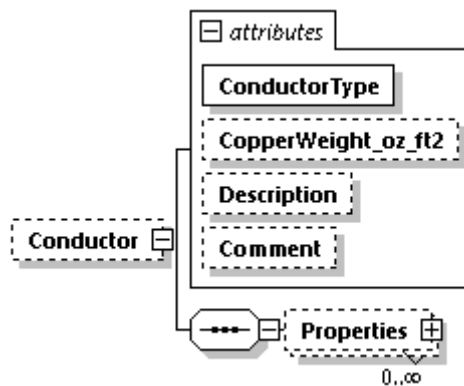
StackupFile/SupplierData/Specs/Spec/Material/Conductor

The definition of a specific piece of conductive material.

Parent

“[StackupFile/SupplierData/Specs/Spec/Material](#)” on page 399

Diagram



Occurrence

0-1

Attributes

Name	Type	Use	Default	Description
ConductorType	ConductorType	required		The type of conductor (COPPER or OTHER).
CopperWeight_oz_ft2	xs:double	optional		Mainly, a historical means to specify copper thickness by using the value of the Thickness attribute located under Material.
Description	xs:string	optional		Open description of the conductive material.
Comment	xs:string	optional		Open comment on the conductive material.

Children

“[StackupFile/SupplierData/Specs/Spec/Material/Conductor/Properties](#)” on page 407

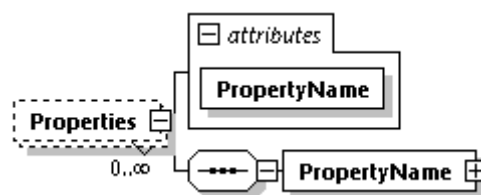
StackupFile/SupplierData/Specs/Spec/Material/Conductor/Properties

Contains a list of Properties related to the material behavior. The Property is selected through the use of the PropertyName attribute.

Parent

“[StackupFile/SupplierData/Specs/Spec/Material/Conductor](#)” on page 405

Diagram



Occurrence

0-n

Attributes

Name	Type	Use	Default	Description
PropertyName	xs:string	required		The name referencing the given set of Properties

Children

“[StackupFile/SupplierData/Specs/Spec/Material/Conductor/Properties/PropertyName](#)” on page 408

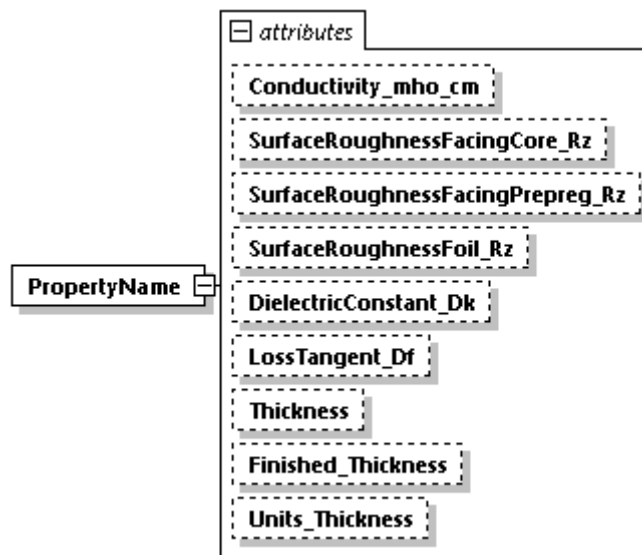
StackupFile/SupplierData/Specs/Spec/Material/Conductor/Properties/PropertyName

A specific property and the related material characteristics.

Parent

[“StackupFile/SupplierData/Specs/Spec/Material/Conductor/Properties”](#) on page 407

Diagram



Occurrence

1

Attributes

Name	Type	Use	Default	Description
Conductivity_mho_cm	xs:double	optional		The Conductivity of copper measured in MHO/CM.
SurfaceRoughnessFacingCore_Rz	xs:double	optional		The surface roughness of copper facing the core, measured in Rz.
SurfaceRoughnessFacingPrepreg_Rz	xs:double	optional		The surface roughness of copper facing the prepreg, measured in Rz.

Name	Type	Use	Default	Description
SurfaceRoughnessFoil_Rz	xs:double	optional		The surface roughness of the copper foil or sheet materials measured in Rz.
DielectricConstant_Dk	xs:double	optional		The Dielectric Constant (DK) contributed to the resin during the lamination process.
LossTangent_Df	xs:double	optional		The Loss Tangent (Df) contributed to the resin during the lamination process.
Thickness	xs:double	optional		The overriding thickness of the conductor material. The unit of measure is governed by StackupFile -> DefaultUnits, which is by default MIL.
Finished_Thickness	xs:double	optional		The overriding finished thickness of the conductor material. The unit of measure is governed by StackupFile -> DefaultUnits, which is by default MIL.
Units_Thickness	UnitsType	optional	ML	The unit of measure used by the Thickness and Finished_Thickness attributes. This unit is governed by StackupFile -> DefaultUnits.

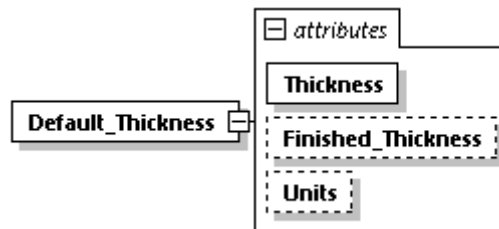
StackupFile/SupplierData/Specs/Spec/Material/Default_Thickness

The thickness definition for the supplier-delivered dielectric or conductor material.

Parent

“[StackupFile/EdaData/Specs/Spec/Material](#)” on page 336

Diagram



Occurrence

1

Attributes

Name	Type	Use	Default	Description
Thickness	xs:double	required		The default thickness of the dielectric or conductor material. The unit of measure is governed by StackupFile -> DefaultUnits, which is by default MIL.
Finished_Thickness	xs:double	optional		The default finished thickness of the dielectric or conductor material. The unit of measure is governed by StackupFile -> DefaultUnits, which is by default MIL.
Units	xs:double	optional	MIL	The unit value of measure used by the Thickness and Finished_Thickness attributes. This unit is governed by StackupFile -> DefaultUnits.

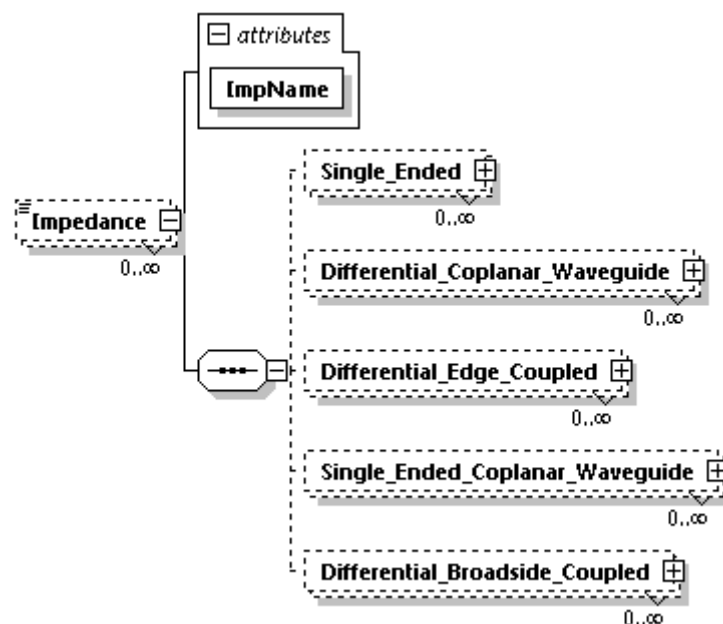
StackupFile/SupplierData/Specs/Spec/Impedance

An Impedance specification defining the general impedance goal and physical characteristics. The Impedance is selected through the use of the ImplName attribute.

Parent

“[StackupFile/SupplierData/Specs/Spec](#)” on page 398

Diagram



Occurrence

0-n

Attributes

Name	Type	Use	Default	Description
ImplName	xs:string	required		The name referencing the given Impedance.

Children

- “[StackupFile/SupplierData/Specs/Spec/Impedance/Single_Ended](#)” on page 413

- “[StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Coplanar_Waveguide](#)” on page 418
- “[StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Edge_Coupled](#)” on page 427
- “[StackupFile/SupplierData/Specs/Spec/Impedance/Single_Ended_Coplanar_Waveguide](#)” on page 433
- “[StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Broadside_Coupled](#)” on page 441

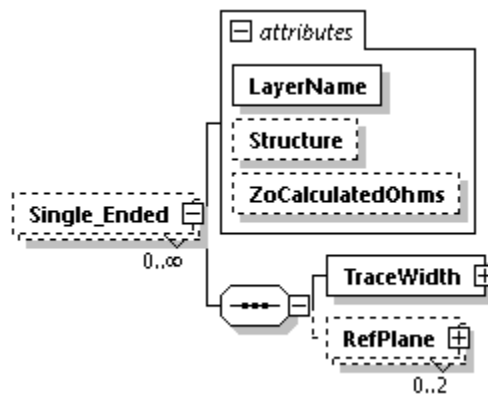
StackupFile/SupplierData/Specs/Spec/Impedance/Single_Ended

A representation of the single-ended impedance requirement.

Parent

“[StackupFile/SupplierData/Specs/Spec/Impedance](#)” on page 411

Diagram



Occurrence

0-n

Attributes

Name	Type	Use	Default	Description
LayerName	xs:string	required		The Layer name referencing the given Impedance Type.
Structure	Structure	optional		The impedance structure definition in the areas of stripline, microstrip, or Coplanar waveguide.
ZoCalculatedOhms	xs:double	optional		The calculated result for the given single-ended impedance instance.

Children

- “[StackupFile/SupplierData/Specs/Spec/Impedance/Single_Ended/TraceWidth](#)” on page 415

- “[StackupFile/SupplierData/Specs/Spec/Impedance/Single_Ended/RefPlane](#)” on page 417

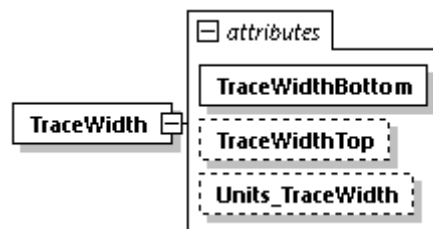
StackupFile/SupplierData/Specs/Spec/Impedance/Single_Ended/TraceWidth

Contains the required trace width for the calculated impedance.

Parent

“[StackupFile/SupplierData/Specs/Spec/Impedance/Single_Ended](#)” on page 413

Diagram



Occurrence

1

Attributes

Name	Type	Use	Default	Description
TraceWidthBottom	xs:double	required		<p>After the etching process, traces have a trapezoidal shape, with the top of the copper narrower than the bottom. This attribute contains the width of the bottom of a trace located on the design.</p> <p>For conductor layer types, this value is required.</p> <p>The unit of measure is governed by StackupFile -> DefaultUnits, which is by default MIL.</p>

Name	Type	Use	Default	Description
TraceWidthTop	xs:double	optional		<p>After the etching process, traces have a trapezoidal shape, with the top of the copper narrower than the bottom. This attribute contains the width of the top of a trace located on the design.</p> <p>If not present, then the value of TraceWidthBottom is used.</p> <p>The unit of measure is governed by StackupFile -> DefaultUnits, which is by default MIL.</p>
Units_TraceWidth	UnitsType	optional	MIL	The unit of measure used by the TraceWidthTop and TraceWidthBottom attributes.

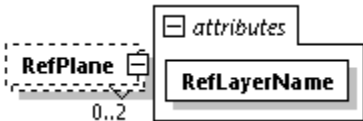
StackupFile/SupplierData/Specs/Spec/Impedance/Single_Ended/RefPlane

Contains the list of layers that represent the reference planes in impedance calculation.

Parent

“[StackupFile/SupplierData/Specs/Spec/Impedance/Single_Ended](#)” on page 413

Diagram



Occurrence

0-2

Attributes

Name	Type	Use	Default	Description
RefLayerName	xs:string	required		The LayerName value of the layer found under StackupFile -> EdaData -> Stackup -> Group -> Layer. This value represents a reference plane used during the impedance calculation.

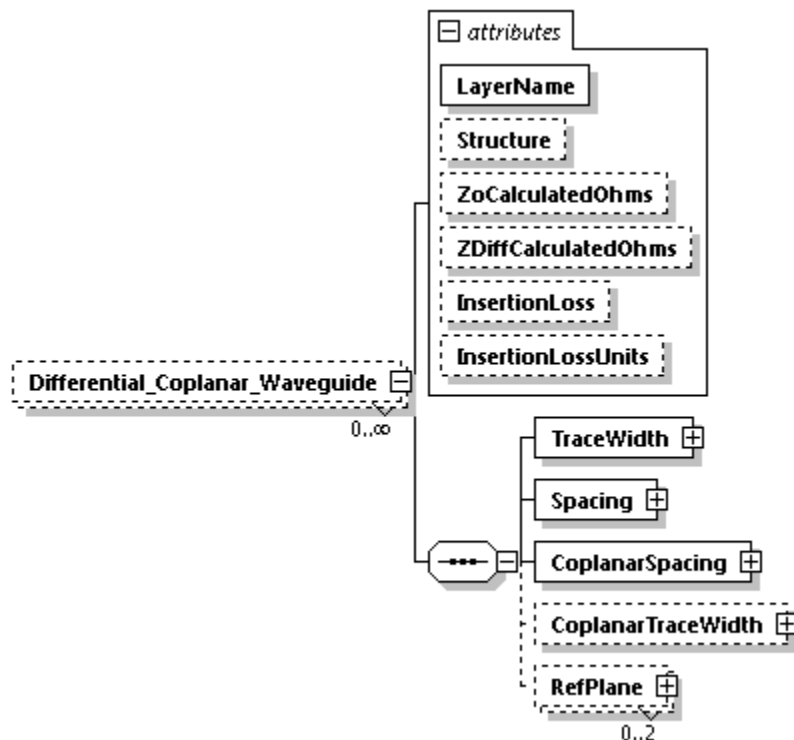
StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Coplanar_Waveguide

A representation of the differential Coplanar waveguide impedance requirement.

Parent

“[StackupFile/SupplierData/Specs/Spec/Impedance](#)” on page 411

Diagram



Occurrence

0-n

Attributes

Name	Type	Use	Default	Description
LayerName	xs:string	required		The Layer name referencing the given Impedance Type

Name	Type	Use	Default	Description
Structure	Structure	optional		The impedance structure definition in the areas of stripline, microstrip, or Coplanar waveguide
ZoCalculatedOhms	xs:double	optional		The calculated result for the given single-ended impedance instance
ZDiffCalculatedOhms	xs:double	optional		The calculated result for the given differential impedance instance
InsertionLoss	xs:double	optional		The resulting loss of single power
InsertionLossUnits	InsertionLossType	optional	DB/INCH	Units for InsertionLoss

Children

- “[StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Coplanar_Waveguide/TraceWidth](#)” on page 420
- “[StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Coplanar_Waveguide/Spacing](#)” on page 422
- “[StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Coplanar_Waveguide/CoplanarSpacing](#)” on page 423
- “[StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Coplanar_Waveguide/CoplanarTraceWidth](#)” on page 424
- “[StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Coplanar_Waveguide/RefPlane](#)” on page 426

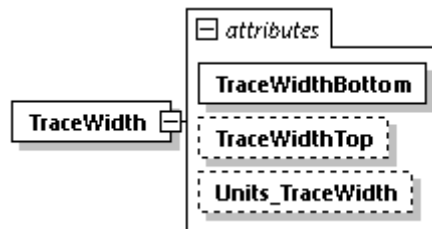
StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Coplanar_Waveguide/TraceWidth

Contains the required trace width for the calculated impedance.

Parent

“[StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Coplanar_Waveguide](#)” on page 418

Diagram



Occurrence

1

Attributes

Name	Type	Use	Default	Description
TraceWidthBottom	xs:double	required		<p>After the etching process, traces have a trapezoidal shape, with the top of the copper narrower than the bottom. This attribute contains the width of the bottom of a trace located on the design.</p> <p>For conductor layer types, this value is required.</p> <p>The unit of measure is governed by StackupFile -> DefaultUnits, which is by default MIL.</p>

Name	Type	Use	Default	Description
TraceWidthTop	xs:double	optional		<p>After the etching process, traces have a trapezoidal shape, with the top of the copper narrower than the bottom. This attribute contains the width of the top of a trace located on the design.</p> <p>If not present, then the value of TraceWidthBottom is used.</p> <p>The unit of measure is governed by StackupFile -> DefaultUnits, which is by default MIL.</p>
Units_TraceWidth	UnitsType	optional	MIL	The unit of measure used by the TraceWidthTop and TraceWidthBottom attributes.

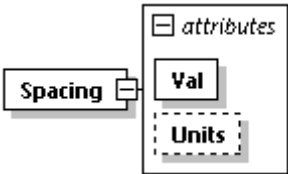
StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Coplanar_Waveguide/Spacing

Contains the required spacing between copper for the calculated impedance.

Parent

“[StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Coplanar_Waveguide](#)” on page 418

Diagram



Occurrence

1

Attributes

Name	Type	Use	Default	Description
Val	xs:double	required		The required spacing for the related conductor
Units	UnitsType	optional	MIL	The unit of measure used by the Val attribute

StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Coplanar_Waveguide/CoplanarSpacing

Contains the required Coplanar spacing for the calculated impedance.

Parent

“[StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Coplanar_Waveguide](#)” on page 418

Diagram



Occurrence

1

Attributes

Name	Type	Use	Default	Description
Val	xs:double	required		The required Coplanar spacing for the related conductor
Units	UnitsType	optional	MIL	The unit of measure used by the Val attribute

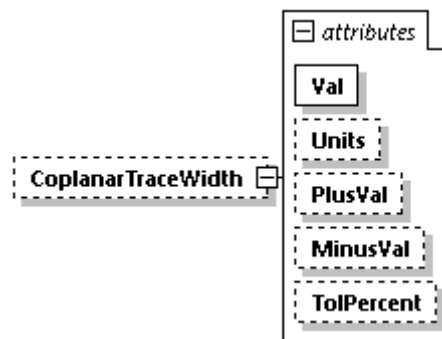
StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Coplanar_Waveguide/CoplanarTraceWidth

Contains the required trace width for the calculated impedance.

Parent

“[StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Coplanar_Waveguide](#)” on page 418

Diagram



Occurrence

0-1

Attributes

Name	Type	Use	Default	Description
TraceWidthBottom	xs:double	required		<p>After the etching process, traces have a trapezoidal shape, with the top of the copper narrower than the bottom. This attribute contains the width of the bottom of a trace located on the design.</p> <p>For conductor layer types, this value is required.</p> <p>The unit of measure is governed by StackupFile -> DefaultUnits, which is by default MIL.</p>

Name	Type	Use	Default	Description
TraceWidthTop	xs:double	optional		<p>After the etching process, traces have a trapezoidal shape, with the top of the copper narrower than the bottom. This attribute contains the width of the top of a trace located on the design.</p> <p>If not present, then the value of TraceWidthBottom is used.</p> <p>The unit of measure is governed by StackupFile -> DefaultUnits, which is by default MIL.</p>
Units_TraceWidth	UnitsType	optional	MIL	The unit of measure used by the TraceWidthTop and TraceWidthBottom attributes.

StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Coplanar_Waveguide/RefPlane

Contains the list of layers that represent the reference planes in impedance calculation.

Parent

“[StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Coplanar_Waveguide](#)” on page 418

Diagram



Occurrence

0-2

Attributes

Name	Type	Use	Default	Description
RefLayerName	xs:string	required		The LayerName value of the layer found under StackupFile -> EdaData -> Stackup -> Group -> Layer. This value represents a reference plane used during the impedance calculation.

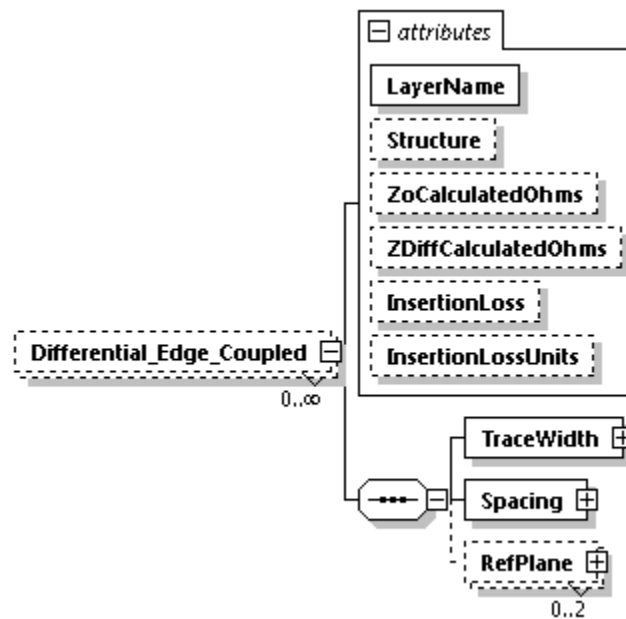
StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Edge_Coupled

A representation of the edge-coupled differential impedance requirement.

Parent

“[StackupFile/SupplierData/Specs/Spec/Impedance](#)” on page 411

Diagram



Occurrence

0-n

Attributes

Name	Type	Use	Default	Description
LayerName	xs:string	required		The Layer name referencing the given Impedance Type
Structure	Structure	optional		The impedance structure definition in the areas of stripline, microstrip, or Coplanar waveguide

Name	Type	Use	Default	Description
ZoCalculatedOhms	xs:double	optional		The calculated result for the given single-ended impedance instance
ZDiffCalculateOhms	xs:double	optional		The calculated result for the given differential impedance instance
InsertionLoss	xs:double	optional		The resulting loss of single power
InsertionLossUnits	InsertionLossType	optional	DB/INCH	Units for InsertionLoss

Children

- “[StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Edge_Coupled/TraceWidth](#)” on page 429
- “[StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Edge_Coupled/Spacing](#)” on page 431
- “[StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Edge_Coupled/RefPlane](#)” on page 432

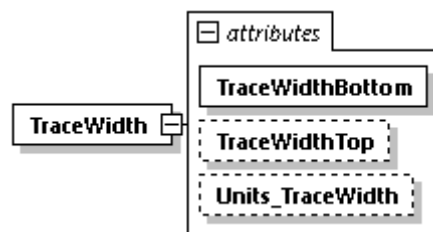
StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Edge_Coupled/TraceWidth

Contains the required trace width for the calculated impedance.

Parent

“[StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Edge_Coupled](#)” on page 427

Diagram



Occurrence

1

Attributes

Name	Type	Use	Default	Description
TraceWidthBottom	xs:double	required		<p>After the etching process, traces have a trapezoidal shape, with the top of the copper narrower than the bottom. This attribute contains the width of the bottom of a trace located on the design.</p> <p>For conductor layer types, this value is required.</p> <p>The unit of measure is governed by StackupFile -> DefaultUnits, which is by default MIL.</p>

Name	Type	Use	Default	Description
TraceWidthTop	xs:double	optional		<p>After the etching process, traces have a trapezoidal shape, with the top of the copper narrower than the bottom. This attribute contains the width of the top of a trace located on the design.</p> <p>If not present, then the value of TraceWidthBottom is used.</p> <p>The unit of measure is governed by StackupFile -> DefaultUnits, which is by default MIL.</p>
Units_TraceWidth	UnitsType	optional	MIL	The unit of measure used by the TraceWidthTop and TraceWidthBottom attributes.

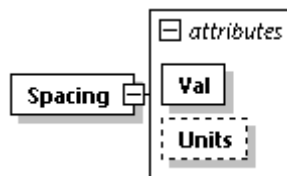
StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Edge_Coupled/Spacing

Contains the required spacing between copper for the calculated impedance.

Parent

[“StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Edge_Coupled”](#) on page 427

Diagram



Occurrence

1

Attributes

Name	Type	Use	Default	Description
Val	xs:double	required		The required spacing for the related conductor
Units	UnitsType	optional	MIL	The unit of measure used by the Val attribute

StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Edge_Coupled/RefPlane

Contains the list of layers that represent the reference planes in impedance calculation.

Parent

[“StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Edge_Coupled”](#) on page 427

Diagram



Occurrence

0-2

Attributes

Name	Type	Use	Default	Description
RefLayerName	xs:string	required		The LayerName value of the layer found under StackupFile -> EdaData -> Stackup -> Group -> Layer. This value represents a reference plane used during the impedance calculation.

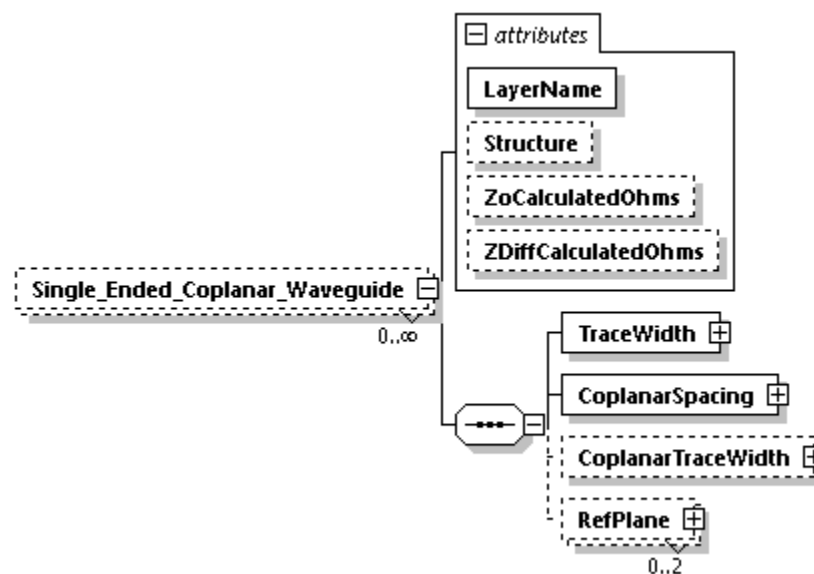
StackupFile/SupplierData/Specs/Spec/Impedance/Single_Ended_Coplanar_Waveguide

A representation of the Coplanar single-ended waveguide impedance requirement.

Parent

“[StackupFile/SupplierData/Specs/Spec/Impedance](#)” on page 411

Diagram



Occurrence

0-n

Attributes

Name	Type	Use	Default	Description
LayerName	xs:string	required		The Layer name referencing the given Impedance Type
Structure	Structure	optional		The impedance structure definition in the areas of stripline, microstrip, or Coplanar waveguide

Name	Type	Use	Default	Description
ZoCalculatedOhms	xs:double	optional		The calculated result for the given single-ended impedance instance
ZDiffCalculateOhms	xs:double	optional		The calculated result for the given differential impedance instance

Children

- [“StackupFile/SupplierData/Specs/Spec/Impedance/Single_Ended_Coplanar_Waveguide/TraceWidth”](#) on page 435
- [“StackupFile/SupplierData/Specs/Spec/Impedance/Single_Ended_Coplanar_Waveguide/CoplanarSpacing”](#) on page 437
- [“StackupFile/SupplierData/Specs/Spec/Impedance/Single_Ended_Coplanar_Waveguide/CoplanarTraceWidth”](#) on page 438
- [“StackupFile/SupplierData/Specs/Spec/Impedance/Single_Ended_Coplanar_Waveguide/RefPlane”](#) on page 440

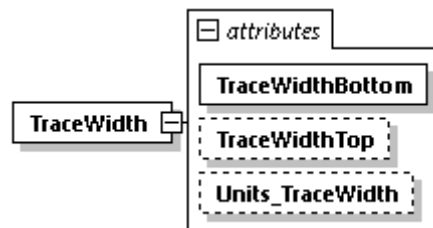
StackupFile/SupplierData/Specs/Spec/Impedance/Single_Ended_Coplanar_Waveguide/TraceWidth

Contains the required trace width for the calculated impedance.

Parent

“[StackupFile/SupplierData/Specs/Spec/Impedance/Single_Ended_Coplanar_Waveguide](#)” on page 433

Diagram



Occurrence

1

Attributes

Name	Type	Use	Default	Description
TraceWidthBottom	xs:double	required		<p>After the etching process, traces have a trapezoidal shape, with the top of the copper narrower than the bottom. This attribute contains the width of the bottom of a trace located on the design.</p> <p>For conductor layer types, this value is required.</p> <p>The unit of measure is governed by StackupFile -> DefaultUnits, which is by default MIL.</p>

Name	Type	Use	Default	Description
TraceWidthTop	xs:double	optional		<p>After the etching process, traces have a trapezoidal shape, with the top of the copper narrower than the bottom. This attribute contains the width of the top of a trace located on the design.</p> <p>If not present, then the value of TraceWidthBottom is used.</p> <p>The unit of measure is governed by StackupFile -> DefaultUnits, which is by default MIL.</p>
Units_TraceWidth	UnitsType	optional	MIL	The unit of measure used by the TraceWidthTop and TraceWidthBottom attributes.

StackupFile/SupplierData/Specs/Spec/Impedance/Single_Ended_Coplanar_Waveguide/CoplanarSpacing

Contains the required spacing between copper for the calculated impedance.

Parent

“[StackupFile/SupplierData/Specs/Spec/Impedance/Single_Ended_Coplanar_Waveguide](#)” on page 433

Diagram



Occurrence

1

Attributes

Name	Type	Use	Default	Description
Val	xs:double	required		The required Coplanar spacing for the related conductor
Units	UnitsType	optional	MIL	The unit of measure used by the Val attribute

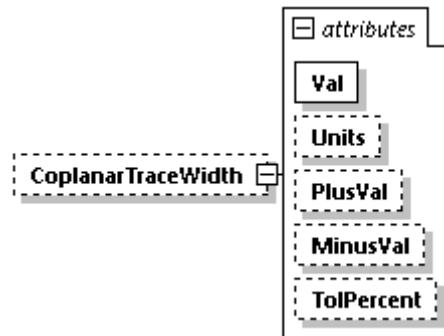
StackupFile/SupplierData/Specs/Spec/ Impedance/ Single_Ended_Coplanar_Waveguide/ CoplanarTraceWidth

Contains the required coplanar trace width for the calculated impedance. When using reference planes, this element is not to be defined.

Parent

“[StackupFile/SupplierData/Specs/Spec/Impedance/Single_Ended_Coplanar_Waveguide](#)” on page 433

Diagram



Occurrence

0-1

Attributes

Name	Type	Use	Default	Description
TraceWidthBottom	xs:double	required		<p>After the etching process, traces have a trapezoidal shape, with the top of the copper narrower than the bottom. This attribute contains the width of the bottom of a trace located on the design.</p> <p>For conductor layer types, this value is required.</p> <p>The unit of measure is governed by StackupFile -> DefaultUnits, which is by default MIL.</p>
TraceWidthTop	xs:double	optional		<p>After the etching process, traces have a trapezoidal shape, with the top of the copper narrower than the bottom. This attribute contains the width of the top of a trace located on the design.</p> <p>If not present, then the value of TraceWidthBottom is used.</p> <p>The unit of measure is governed by StackupFile -> DefaultUnits, which is by default MIL.</p>
Units_TraceWidth	UnitsType	optional	MIL	The unit of measure used by the TraceWidthTop and TraceWidthBottom attributes.

StackupFile/SupplierData/Specs/Spec/ Impedance/ Single_Ended_Coplanar_Waveguide/RefPlane

Contains the list of layers that represent the reference planes in impedance calculation.

Parent

“[StackupFile/SupplierData/Specs/Spec/Impedance/Single_Ended_Coplanar_Waveguide](#)” on page 433

Diagram



Occurrence

0-2

Attributes

Name	Type	Use	Default	Description
RefLayerName	xs:string	required		The LayerName value of the layer found under StackupFile -> EdaData -> Stackup -> Group -> Layer. This value represents a reference plane used during the impedance calculation.

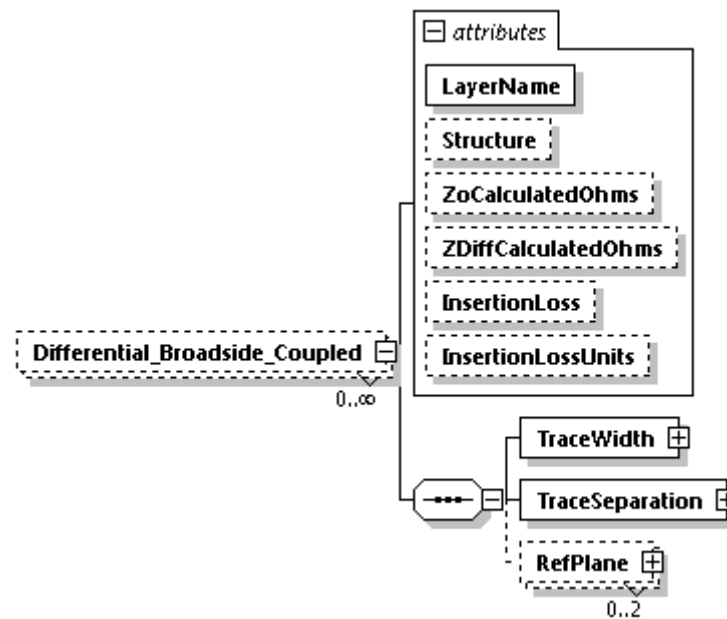
StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Broadside_Coupled

A representation of the broadside-coupled differential impedance requirement.

Parent

“[StackupFile/SupplierData/Specs/Spec/Impedance](#)” on page 411

Diagram



Occurrence

0-n

Attributes

Name	Type	Use	Default	Description
LayerName	xs:string	required		The Layer name referencing the given Impedance Type
Structure	Structure	optional		The impedance structure definition in the areas of stripline, microstrip, or Coplanar waveguide

Name	Type	Use	Default	Description
ZoCalculatedOhm	xs:double	optional		The calculated result for this single-ended impedance instance
ZDiffCalculatedOhms	xs:double	optional		The calculated result for this differential impedance instance
InsertionLoss	xs:double	optional		The resulting loss of single power
InsertionLossUnits	InsertionLossType	optional	DB/INCH	Units for InsertionLoss

Children

- “[StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Broadside_Coupled/TraceWidth](#)” on page 443
- “[StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Broadside_Coupled/TraceSeparation](#)” on page 445
- “[StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Broadside_Coupled/RefPlane](#)” on page 446

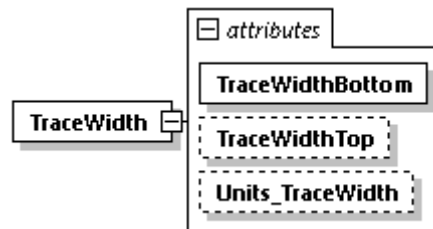
StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Broadside_Coupled/TraceWidth

Contains the required trace width for the calculated impedance.

Parent

“[StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Broadside_Coupled](#)” on page 441

Diagram



Occurrence

1

Attributes

Name	Type	Use	Default	Description
TraceWidthBottom	xs:double	required		<p>After the etching process, traces have a trapezoidal shape, with the top of the copper narrower than the bottom. This attribute contains the width of the bottom of a trace located on the design.</p> <p>For conductor layer types, this value is required.</p> <p>The unit of measure is governed by StackupFile -> DefaultUnits, which is by default MIL.</p>

Name	Type	Use	Default	Description
TraceWidthTop	xs:double	optional		<p>After the etching process, traces have a trapezoidal shape, with the top of the copper narrower than the bottom. This attribute contains the width of the top of a trace located on the design.</p> <p>If not present, then the value of TraceWidthBottom is used.</p> <p>The unit of measure is governed by StackupFile -> DefaultUnits, which is by default MIL.</p>
Units_TraceWidth	UnitsType	optional	MIL	The unit of measure used by the TraceWidthTop and TraceWidthBottom attributes.

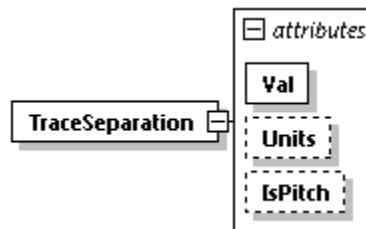
StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Broadside_Coupled/TraceSeparation

Contains the required distance between the related conductors.

Parent

“[StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Broadside_Coupled](#)” on page 441

Diagram



Occurrence

1

Attributes

Name	Type	Use	Default	Description
Val	xs:double	required		The required copper separation value for the related conductors
Units	UnitsType	optional	MIL	The unit of measure used by the Val attribute
IsPitch	xs:boolean	optional	true	Trace Separation definition: true — the spacing between the conductors is measured from center line to center line, or pitch false — the spacing between the conductors is measured from edge to edge

StackupFile/SupplierData/Specs/Spec/ Impedance/Differential_Broadside_Coupled/ RefPlane

Contains the list of layers that represent the reference planes in impedance calculation.

Parent

“[StackupFile/SupplierData/Specs/Spec/Impedance/Differential_Broadside_Coupled](#)” on page 441

Diagram



Occurrence

0-2

Attributes

Name	Type	Use	Default	Description
RefLayerName	xs:string	required		The LayerName value of the layer found under StackupFile -> EdaData -> Stackup -> Group -> Layer. This value represents a reference plane used during the impedance calculation.

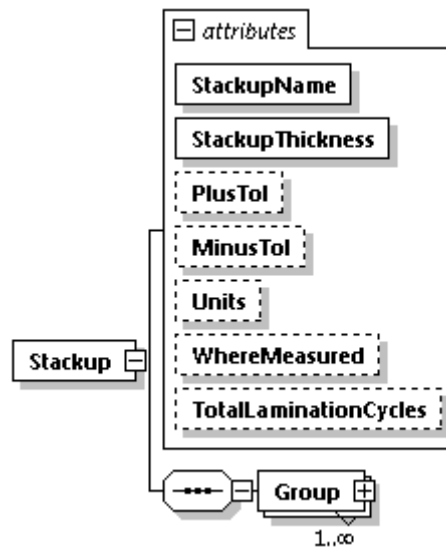
StackupFile/SupplierData/Stackup

Contains the manufacturing stackup representation determined by the supplier.

Parent

“[StackupFile/SupplierData](#)” on page 395

Diagram



Occurrence

1

Attributes

Name	Type	Use	Default	Description
StackupName	xs:string	required		The name referencing the given Stackup.
StackupThickness	xs:double	required		The calculated board thickness.
Status	StackupStatus	optional	SUBMITTED	The stackup status.

Name	Type	Use	Default	Description
Units	UnitsType	optional	MIL	The unit of measure used by the StackupThickness, PlusTol, and MinusTol attributes. This unit is governed by StackupFile -> DefaultUnits.
WhereMeasured	WhereMeasured	optional	METAL	An enumerated value indicating where to measure the StackupThickness value.
TotalLaminationCycles	xs:integer	optional		The total number of lamination cycles required to complete the booking process.

Children

“[StackupFile/SupplierData/Stackup/Group](#)” on page 449

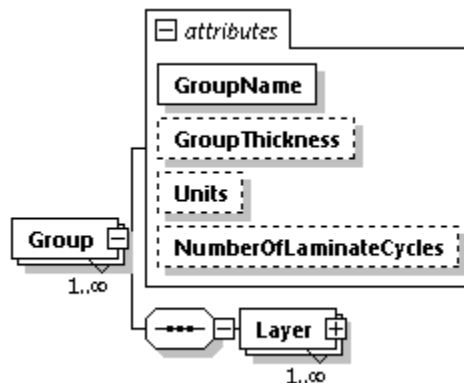
StackupFile/SupplierData/Stackup/Group

A stackup is created from Groups. A Group is a collection of Materials in which conductor materials are tied to copper layers of the design. Each series is represented from the top of the stack to the bottom.

Parent

“[StackupFile/SupplierData/Stackup](#)” on page 447

Diagram



Occurrence

1-n

Attributes

Name	Type	Use	Default	Description
GroupName	xs:string	required		The name referencing the given Group.
GroupThickness	xs:double	optional		The total thickness for the group of layers, in units defined in the Units attribute.
Units	UnitsType	optional	MIL	The unit of measure used by the GroupThickness attribute. This unit is governed by StackupFile -> DefaultUnits.
NumberOfLaminateCycles	xs:integer	optional		The total number of lamination cycles to subject the layer group, from the beginning to the end of the booking process.

Children

[“StackupFile/SupplierData/Stackup/Group/Layer”](#) on page 451

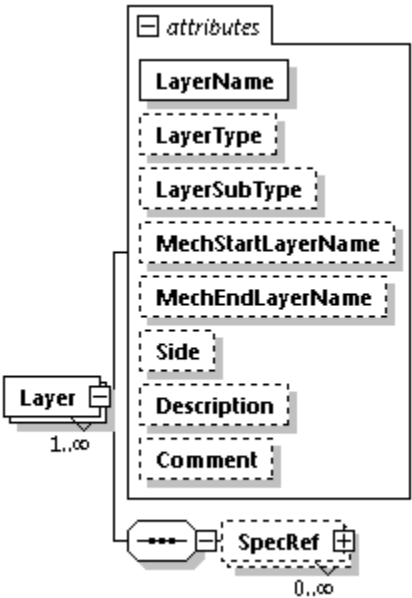
StackupFile/SupplierData/Stackup/Group/Layer

A layer definition within the Group.

Parent

“[StackupFile/SupplierData/Stackup/Group](#)” on page 449

Diagram



Occurrence

1-n

Attributes

Name	Type	Use	Default	Description
LayerName	xs:string	required		The name of the layer, in most cases, found in the section EdaData -> Stackup -> Group -> Layer. If the following Layer attributes are missing, they are taken from that reference. Otherwise, they may need to be added.

Name	Type	Use	Default	Description
LayerType	LayerType	optional	DOCUMENT	An enumerated list of layer types representing the purpose of the layer.
LayerSubType	LayerSubType	optional		An enumerated list of layer subtypes that refine the LayerType value. For example, a LayerType DRILL with a SubType BACKDRILL.
MechStartLayerName	xs:string	optional		If LayerType has the value of DRILL or ROUT, this attribute contains the name of the initial layer where the material is mechanically penetrated.
MechEndLayerName	xs:string	optional		If LayerType has the value of DRILL or ROUT, this attribute contains the name of the final layer where the material is mechanically penetrated.
Side	SideType	optional	NONE	An enumerated list of a values declaring the relative position of the layer within the stackup.
Description	xs:string	optional		Open description from the design company of the originating layer.
Comment	xs:string	optional		Open comment from the design company of the originating layer.

Children

“[StackupFile/EdaData/Stackup/Group/Layer/SpecRef](#)” on page 391

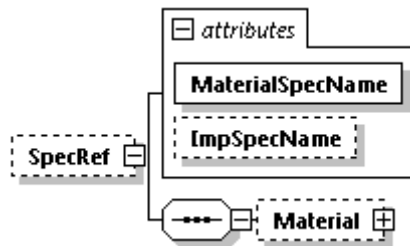
StackupFile/SupplierData/Stackup/Group/Layer/SpecRef

The list of Material and Impedance Specs, and conductor requirements for a layer.

Parent

“[StackupFile/SupplierData/Stackup/Group/Layer](#)” on page 451

Diagram



Occurrence

0-n

Attributes

Name	Type	Use	Default	Description
MaterialSpecName	xs:string	required		The name referencing the selected Material Spec
ImpSpecName	xs:string	optional		The name referencing the selected Impedance Spec

Children

“[StackupFile/SupplierData/Stackup/Group/Layer/SpecRef/Material](#)” on page 454

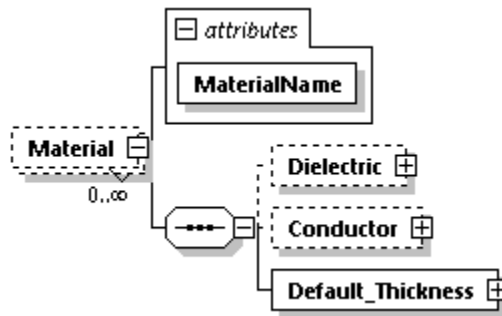
StackupFile/SupplierData/Stackup/Group/Layer/SpecRef/Material

Defines the Material requirements for a layer.

Parent

“[StackupFile/SupplierData/Stackup/Group/Layer/SpecRef](#)” on page 453

Diagram



Occurrence

0-1

Attributes

Name	Type	Use	Default	Description
MaterialName	xs:string	required		The name referencing the designated Material within the referenced SpecName.
PropertyName	xs:string	optional		The name referencing the designated Properties within the referenced Material. If only one Property is defined, then this Property is considered the default, and the existence of the attribute FrequencyVal is not required.

Name	Type	Use	Default	Description
FrequencyVal	xs:double	optional		The frequency of the signal on the net. This attribute can reference additional material content when referenced into FrequencyName. If only one Frequency is defined, then it is considered the default, and the existence of this attribute is not required.
CopperAreaPercent	xs:double	optional		Percentage calculated by dividing the copper area of the layer by the total area of the layer laminate.

Stackup Schema File

This is the full schema file.

```
<?xml version="1.0" encoding="Windows-1252"?>
<!-- edited with XMLSpy v2020 sp1 (x64) (http://www.altova.com) by Nina
Kaluta (Mentor Graphics) -->
<xs:schema xmlns:vc="http://www.w3.org/2007/XMLSchema-versioning"
xmlns:xs="http://www.w3.org/2001/XMLSchema"
elementFormDefault="qualified" attributeFormDefault="unqualified"
vc:minVersion="1.1">
  <xs:simpleType name="Polarity">
    <xs:restriction base="xs:string">
      <xs:enumeration value="POSITIVE"/>
      <xs:enumeration value="NEGATIVE"/>
    </xs:restriction>
  </xs:simpleType>
  <xs:simpleType name="LayerType">
    <xs:restriction base="xs:string">
      <xs:enumeration value="SIGNAL"/>
      <xs:enumeration value="POWER_GROUND"/>
      <xs:enumeration value="MIXED"/>
      <xs:enumeration value="SOLDER_MASK"/>
      <xs:enumeration value="SILK_SCREEN"/>
      <xs:enumeration value="SOLDER_PASTE"/>
      <xs:enumeration value="DRILL"/>
      <xs:enumeration value="ROUT"/>
      <xs:enumeration value="DOCUMENT"/>
      <xs:enumeration value="MASK"/>
      <xs:enumeration value="DIELECTRIC"/>
      <xs:enumeration value="CONDUCTIVE_PASTE"/>
      <xs:enumeration value="COMPONENT"/>
      <xs:enumeration value="POWER"/>
      <xs:enumeration value="GROUND"/>
    </xs:restriction>
  </xs:simpleType>
  <xs:simpleType name="LayerSubType">
    <xs:restriction base="xs:string">
      <xs:enumeration value="PUNCH"/>
      <xs:enumeration value="BACKDRILL"/>
      <xs:enumeration value="DUAL_DIAMETER"/>
      <xs:enumeration value="EMBEDDED_R"/>
      <xs:enumeration value="EMBEDDED_C"/>
      <xs:enumeration value="COVERLAY"/>
      <xs:enumeration value="COVERCOAT"/>
      <xs:enumeration value="STIFFENER"/>
      <xs:enumeration value="BEND_AREA"/>
      <xs:enumeration value="PSA"/>
      <xs:enumeration value="MIXED_FLEX"/>
      <xs:enumeration value="PG_FLEX"/>
      <xs:enumeration value="SIGNAL_FLEX"/>
      <xs:enumeration value="AREA"/>
      <xs:enumeration value="DRAWING"/>
      <xs:enumeration value="SILVER_MASK"/>
      <xs:enumeration value="OSP_MASK"/>
      <xs:enumeration value="IMMERSION_MASK"/>
      <xs:enumeration value="PLATING_MASK"/>
      <xs:enumeration value="CARBON_MASK"/>
      <xs:enumeration value="CORE"/>
      <xs:enumeration value="PREPREG"/>
      <xs:enumeration value="WIRE_BONDING"/>
      <xs:enumeration value="FLEX_AREA"/>
    </xs:restriction>
  </xs:simpleType>

```



```
<xs:enumeration value="RIGID_AREA"/>
</xs:restriction>
</xs:simpleType>
<xs:simpleType name="Context">
  <xs:restriction base="xs:string">
    <xs:enumeration value="BOARD"/>
    <xs:enumeration value="MISC"/>
  </xs:restriction>
</xs:simpleType>
<xs:simpleType name="SideType">
  <xs:restriction base="xs:string">
    <xs:enumeration value="NONE"/>
    <xs:enumeration value="TOP"/>
    <xs:enumeration value="BOTTOM"/>
    <xs:enumeration value="INNER"/>
  </xs:restriction>
</xs:simpleType>
<xs:simpleType name="UnitsType">
  <xs:restriction base="xs:string">
    <xs:enumeration value="MM"/>
    <xs:enumeration value="MICRON"/>
    <xs:enumeration value="INCH"/>
    <xs:enumeration value="MIL"/>
  </xs:restriction>
</xs:simpleType>
<xs:simpleType name="WhereMeasured">
  <xs:restriction base="xs:string">
    <xs:enumeration value="LAMINATE"/>
    <xs:enumeration value="METAL"/>
    <xs:enumeration value="MASK"/>
    <xs:enumeration value="OTHER"/>
  </xs:restriction>
</xs:simpleType>
<xs:simpleType name="Structure">
  <xs:restriction base="xs:string">
    <xs:enumeration value="STRIPLINE"/>
    <xs:enumeration value="PLANE_LESS_STRIPLINE"/>
    <xs:enumeration value="MICROSTRIP_EMBEDDED"/>
    <xs:enumeration value="MICROSTRIP_NO_MASK"/>
    <xs:enumeration value="MICROSTRIP_MASK_COVERED"/>
    <xs:enumeration value="COPLANAR_WAVEGUIDED_STRIPLINE"/>
    <xs:enumeration value="COPLANAR_WAVEGUIDED_NO_MASK"/>
    <xs:enumeration value="COPLANAR_WAVEGUIDED_MASK_COVERED"/>
  </xs:restriction>
</xs:simpleType>
<xs:simpleType name="DielectricType">
  <xs:restriction base="xs:string">
    <xs:enumeration value="PREPREG"/>
    <xs:enumeration value="CORE"/>
    <xs:enumeration value="OTHER"/>
    <xs:enumeration value="UNDEFINED"/>
  </xs:restriction>
</xs:simpleType>
<xs:simpleType name="ConductorType">
  <xs:restriction base="xs:string">
    <xs:enumeration value="COPPER"/>
    <xs:enumeration value="OTHER"/>
  </xs:restriction>
```

```
</xs:simpleType>
<xs:simpleType name="FrequencyType">
  <xs:restriction base="xs:string">
    <xs:enumeration value="Hz"/>
    <xs:enumeration value="MHz"/>
    <xs:enumeration value="GHz"/>
  </xs:restriction>
</xs:simpleType>
<xs:simpleType name="OtherType">
  <xs:restriction base="xs:string">
    <xs:enumeration value="COVERLAY"/>
    <xs:enumeration value="COVERCOAT"/>
    <xs:enumeration value="STIFFENER"/>
    <xs:enumeration value="PRESSURE_SENSITIVE_ADHESIVE"/>
    <xs:enumeration value="OSP_MASK"/>
    <xs:enumeration value="SILVER_MASK"/>
    <xs:enumeration value="CARBON_MASK"/>
    <xs:enumeration value="SOLDER_MASK"/>
    <xs:enumeration value="PLATING_MASK"/>
    <xs:enumeration value="IMMERSION_MASK"/>
    <xs:enumeration value="OTHER"/>
  </xs:restriction>
</xs:simpleType>
<xs:simpleType name="ImpedanceType">
  <xs:restriction base="xs:string">
    <xs:enumeration value="SINGLE_ENDED"/>
    <xs:enumeration value="DIFFERENTIAL_COPLANAR_WAVEGUIDED"/>
    <xs:enumeration value="DIFFERENTIAL_EDGE_COUPLE"/>
    <xs:enumeration value="SINGLE_ENDED_COPLANAR_WAVEGUIDED"/>
    <xs:enumeration value="DIFFERENTIAL_BROADSIDE_COUPLED"/>
  </xs:restriction>
</xs:simpleType>
<xs:simpleType name="InsertionLossType">
  <xs:restriction base="xs:string">
    <xs:enumeration value="DB/INCH"/>
    <xs:enumeration value="DB/CM"/>
    <xs:enumeration value="DB/M"/>
  </xs:restriction>
</xs:simpleType>
<xs:simpleType name="StackupStatus">
  <xs:restriction base="xs:string">
    <xs:enumeration value="SELECTED"/>
    <xs:enumeration value="VALID"/>
    <xs:enumeration value="INVALID"/>
    <xs:enumeration value="SUBMITTED"/>
    <xs:enumeration value="UNDER REVIEW"/>
  </xs:restriction>
</xs:simpleType>
<xs:element name="StackupFile">
  <xs:annotation>
    <xs:documentation>The base of ODB++ stackup content that contains
material, impedance and a design based stackup requirement followed by any
number of stackup supplier solutions.</xs:documentation>
  </xs:annotation>
  <xs:complexType>
    <xs:sequence>
      <xs:element name="EdaData" minOccurs="0" maxOccurs="1">
        <xs:annotation>
```

```
<xs:documentation>Contains the all the stackup required content as
delivered by the design source. It maybe be very generic containing basic
material requirements as well as impedance defintion or it may contain a
full stackup based on the design source having a stackup software solution
to use. In either case, this is the basis for all stackup definitions to
begin from and should not be altered in any way by other stackup
suppliers.</xs:documentation>
</xs:annotation>
<xs:complexType>
  <xs:sequence>
    <xs:element name="Specs">
      <xs:annotation>
        <xs:documentation>Contains a list of specification (Spec) of
material used during stack design and impedance requirements.</
xs:documentation>
      </xs:annotation>
    </xs:complexType>
    <xs:sequence>
      <xs:element name="Spec" maxOccurs="unbounded">
        <xs:annotation>
          <xs:documentation>An indiviual Spec defining a collection of
materials and impedance requirements. The Spec is select later through
the use of the SpecName attribute.</xs:documentation>
        </xs:annotation>
      </xs:complexType>
      <xs:sequence>
        <xs:element name="Material" minOccurs="0"
maxOccurs="unbounded">
          <xs:annotation>
            <xs:documentation>A Material specficiation defining a
specific material, dielectric or conductor. The Material is select later
through the use of the MaterialName attribute.</xs:documentation>
          </xs:annotation>
        </xs:complexType>
        <xs:sequence>
          <xs:element name="Dielectric" minOccurs="0">
            <xs:annotation>
              <xs:documentation>A definition of a specific piece of
dielectric material. </xs:documentation>
            </xs:annotation>
          </xs:complexType>
          <xs:sequence>
            <xs:element name="Properties" minOccurs="0"
maxOccurs="unbounded">
              <xs:annotation>
                <xs:documentation>Contains a list of Properties related
to the material behavior. Material's electrical characteristics are
influenced by the frequency of the impedance net.The Property is selected
later through the use of the PropertyName attribute.</xs:documentation>
              </xs:annotation>
            </xs:complexType>
            <xs:sequence>
              <xs:element name="Property" maxOccurs="unbounded">
                <xs:annotation>
                  <xs:documentation>A specific property and the
related material characteristics.</xs:documentation>
                </xs:annotation>
              </xs:complexType>
```

```

        <xs:attribute name="FrequencyVal" type="xs:double"
use="optional">
        <xs:annotation>
        <xs:documentation>The value of the single
frequency. Default is GHz.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="Units" type="FrequencyType"
use="optional" default="GHz">
        <xs:annotation>
        <xs:documentation>The unit of the FrequencyVal
frequency.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="DielectricConstant_Dk"
type="xs:double" use="optional">
        <xs:annotation>
        <xs:documentation>The Dielectric Constant (DK) at
the specified FrequencyVal frequency.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="LossTangent_Df" type="xs:double"
use="optional">
        <xs:annotation>
        <xs:documentation>The Loss Tangent (Df) at the
specified FrequencyVal frequency.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="Thickness" type="xs:double"
use="optional">
        <xs:annotation>
        <xs:documentation>The overriding thickness of the
dielectric material. The default unit of measure is governed by
StackupFile->DefaultUnits which is by default MIL.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="Finished_Thickness"
type="xs:double" use="optional">
        <xs:annotation>
        <xs:documentation>The overriding thickness of the
dielectric material. The default unit of measure is governed by
StackupFile->DefaultUnits which is by default MIL.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="Units_Thickness"
type="UnitsType" use="optional" default="MIL">
        <xs:annotation>
        <xs:documentation>The unit value that the
Thickness and Finished_Thickness attribute is to be measured in. The
default unit of measure is governed by StackupFile->DefaultUnits which is
by default MIL.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        </xs:complexType>
    </xs:sequence>
    <xs:attribute name="PropertyName" type="xs:string"
use="required">

```

```
        <xs:annotation>
          <xs:documentation>The name used to reference the
specific set of Properties.</xs:documentation>
        </xs:annotation>
      </xs:attribute>
    </xs:complexType>
  </xs:element>
</xs:sequence>
  <xs:attribute name="DielectricType" type="DielectticType"
use="required">
    <xs:annotation>
      <xs:documentation>Defines the generic type of
dielectric materials, prepreg or core or other.</xs:documentation>
    </xs:annotation>
  </xs:attribute>
  <xs:attribute name="OtherSubType" type="OtherType"
use="optional">
    <xs:annotation>
      <xs:documentation>A list of material definition that
will most often be used when the DielectricType is OTHER.</
xs:documentation>
    </xs:annotation>
  </xs:attribute>
  <xs:attribute name="MaterialReference" type="xs:string"
use="optional">
    <xs:annotation>
      <xs:documentation>A free string of text that provides
the material suppliers reference name.</xs:documentation>
    </xs:annotation>
  </xs:attribute>
  <xs:attribute name="GlassStyle_Construction"
type="xs:string" use="optional">
    <xs:annotation>
      <xs:documentation>A free string of text that description
the Prepreg glass or Core construction.</xs:documentation>
    </xs:annotation>
  </xs:attribute>
  <xs:attribute name="ResinContent_Percent"
type="xs:double" use="optional">
    <xs:annotation>
      <xs:documentation>The percentage of resin found in the
dielectric material.</xs:documentation>
    </xs:annotation>
  </xs:attribute>
  <xs:attribute name="Description" type="xs:string"
use="optional">
    <xs:annotation>
      <xs:documentation>Open description regarding the
dielectric material.</xs:documentation>
    </xs:annotation>
  </xs:attribute>
  <xs:attribute name="Comment" type="xs:string"
use="optional">
    <xs:annotation>
      <xs:documentation>Open comment regarding the
dielectric material.</xs:documentation>
    </xs:annotation>
  </xs:attribute>
```

```

        </xs:complexType>
    </xs:element>
    <xs:element name="Conductor" minOccurs="0">
        <xs:annotation>
            <xs:documentation>A definition of a specific piece of
conductive material. </xs:documentation>
        </xs:annotation>
        <xs:complexType>
            <xs:sequence>
                <xs:element name="Properties" minOccurs="0"
maxOccurs="unbounded">
                    <xs:annotation>
                        <xs:documentation>Contains a list of Properties related
to the material behavior. The Property is selected later through the use
of the PropertyName attribute.</xs:documentation>
                    </xs:annotation>
                    <xs:complexType>
                        <xs:sequence>
                            <xs:element name="Property">
                                <xs:annotation>
                                    <xs:documentation>A specific property and the
related material characteristics.</xs:documentation>
                                </xs:annotation>
                                <xs:complexType>
                                    <xs:attribute name="Conductivity_mho_cm"
type="xs:double" use="optional">
                                        <xs:annotation>
                                            <xs:documentation>The Conductivity of the copper
measured in MHO/CM.</xs:documentation>
                                        </xs:annotation>
                                        </xs:attribute>
                                        <xs:attribute name="SurfaceRoughnessFacingCore_Rz"
type="xs:double" use="optional">
                                            <xs:annotation>
                                                <xs:documentation>In core materials the surface
roughness of the copper facing the core measured in Rz.</xs:documentation>
                                            </xs:annotation>
                                            </xs:attribute>
                                            <xs:attribute
name="SurfaceRoughnessFacingPrepreg_Rz" type="xs:double" use="optional">
                                                <xs:annotation>
                                                    <xs:documentation>In core materials the surface
roughness of the copper facing the prepreg measured in Rz.</
xs:documentation>
                                                </xs:annotation>
                                                </xs:attribute>
                                                <xs:attribute name="SurfaceRoughnessFoil_Rz"
type="xs:double" use="optional">
                                                    <xs:annotation>
                                                        <xs:documentation>For copper foil or sheet
materials the surface roughness measured in Rz.</xs:documentation>
                                                    </xs:annotation>
                                                    </xs:attribute>
                                                    <xs:attribute name="DielectricConstant_Dk"
type="xs:double" use="optional">
                                                        <xs:annotation>
                                                            <xs:documentation>The Dielectric Constant (DK)
contributed to the resin during the lamination process.</xs:documentation>

```

```
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="LossTangent_Df" type="xs:double"
use="optional">
        <xs:annotation>
        <xs:documentation>The Loss Tangent (Df) at the
scontributed to the resin during the lamination process.</
xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="Thickness" type="xs:double"
use="optional">
        <xs:annotation>
        <xs:documentation>The overrideing thickness of
the conductor material. The default unit of measure is governed by
StackupFile->DefaultUnits which is by default MIL.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="Finished_Thickness"
type="xs:double" use="optional">
        <xs:annotation>
        <xs:documentation>The overriding finished thickness
of the conductor material. The default unit of measure is governed by
StackupFile->DefaultUnits which is by default MIL.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="Units_Thickness"
type="UnitsType" use="optional" default="MIL">
        <xs:annotation>
        <xs:documentation>The unit value that the
Thickness and Finished_Thickness attribute is to be measured in. The
default unit of measure is governed by StackupFile->DefaultUnits which is
by default MIL.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        </xs:complexType>
        </xs:element>
        </xs:sequence>
        <xs:attribute name="PropertyName" type="xs:string"
use="required">
        <xs:annotation>
        <xs:documentation>The name used to reference the
specific set of Properties.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        </xs:complexType>
        </xs:element>
        </xs:sequence>
        <xs:attribute name="ConductorType" type="ConductorType"
use="required">
        <xs:annotation>
        <xs:documentation>The type of conductor. The values
are COPPER or OTHER.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="CopperWeight_oz_ft2" type="xs:double"
use="optional">
        <xs:annotation>
```

```

        <xs:documentation>This is mainly a historical means to
specify copper thickness. The intended value to be used in this case is
Thickness located just under Material.</xs:documentation>
    </xs:annotation>
</xs:attribute>
<xs:attribute name="Description" type="xs:string"
use="optional">
    <xs:annotation>
        <xs:documentation>Open description regarding the
conductive material.</xs:documentation>
    </xs:annotation>
</xs:attribute>
<xs:attribute name="Comment" type="xs:string"
use="optional">
    <xs:annotation>
        <xs:documentation>Open comment regarding the
conductive material.</xs:documentation>
    </xs:annotation>
</xs:attribute>
</xs:complexType>
</xs:element>
<xs:element name="Default_Thickness">
    <xs:annotation>
        <xs:documentation>A definition of the dielectric or
conductor material supplier delivered thickness.</xs:documentation>
    </xs:annotation>
<xs:complexType>
    <xs:attribute name="Thickness" type="xs:double"
use="required">
        <xs:annotation>
            <xs:documentation>The default thickness of the
dielectric or conductor material. The default unit of measure is governed
by StackupFile->DefaultUnits which is by default MIL.</xs:documentation>
        </xs:annotation>
</xs:attribute>
        <xs:attribute name="Finished_Thickness" type="xs:double"
use="optional">
            <xs:annotation>
                <xs:documentation>The default finished thickness of the
dielectric or conductor material. The default unit of measure is governed
by StackupFile->DefaultUnits which is by default MIL.</xs:documentation>
            </xs:annotation>
</xs:attribute>
        <xs:attribute name="Units" type="UnitsType"
default="MIL">
            <xs:annotation>
                <xs:documentation>The unit value that the Thickness and
Finished_Thickness attribute is to be measured in. The default unit of
measure is governed by StackupFile->DefaultUnits which is by default
MIL.</xs:documentation>
            </xs:annotation>
</xs:attribute>
</xs:complexType>
</xs:element>
</xs:sequence>
    <xs:attribute name="MaterialName" type="xs:string"
use="required">
        <xs:annotation>
```



```
        <xs:documentation>The name used to reference the specific
Material.</xs:documentation>
      </xs:annotation>
    </xs:attribute>
  </xs:complexType>
</xs:element>
<xs:element name="Impedance" minOccurs="0"
maxOccurs="unbounded">
  <xs:annotation>
    <xs:documentation>A Impedance specficiation defining the
general impedance goal and then the physical characteristics. The
Impedance is select later through the use of the ImplName attribute.</
xs:documentation>
  </xs:annotation>
  <xs:complexType mixed="true">
    <xs:sequence>
      <xs:element name="Single_Ended" minOccurs="0"
maxOccurs="unbounded">
        <xs:annotation>
          <xs:documentation>A representation of a single-ended
impedance requirement.</xs:documentation>
        </xs:annotation>
        <xs:complexType>
          <xs:sequence>
            <xs:element name="TraceWidth">
              <xs:annotation>
                <xs:documentation>Contains the desired trace width to
use for the target impedance.</xs:documentation>
              </xs:annotation>
              <xs:complexType>
                <xs:attribute name="Val" type="xs:double"
use="required">
                  <xs:annotation>
                    <xs:documentation>Contains the target trace width of
the related conductor. Default units is MIL.</xs:documentation>
                  </xs:annotation>
                </xs:attribute>
                <xs:attribute name="Units" type="UnitsType"
use="optional" default="MIL">
                  <xs:annotation>
                    <xs:documentation>Contains the unit of measure used
for by the value in Val.</xs:documentation>
                  </xs:annotation>
                </xs:attribute>
                <xs:attribute name="PlusVal" type="xs:double"
use="optional">
                  <xs:annotation>
                    <xs:documentation>A positive value representing the
plus tolerance value to added to the target trace (Val) with value.</
xs:documentation>
                  </xs:annotation>
                </xs:attribute>
                <xs:attribute name="MinusVal" type="xs:double"
use="optional">
                  <xs:annotation>
                    <xs:documentation>A positive value representing the
negative tolerance value to subtracted from the target trace (Val) with
value.</xs:documentation>
```

```

        </xs:annotation>
      </xs:attribute>
      <xs:attribute name="TolPercent" type="xs:boolean"
use="optional" default="false">
        <xs:annotation>
          <xs:documentation>Trace width tolerance definition
- if true a percentage of Val, if false an absolute a value, to add or
substracted fromVal.</xs:documentation>
        </xs:annotation>
      </xs:attribute>
    </xs:complexType>
  </xs:element>
  <xs:element name="RefPlane" minOccurs="0" maxOccurs="2">
    <xs:annotation>
      <xs:documentation>Contains the list of layer that
represent the reference planes used during the impedance calculation.</
xs:documentation>
    </xs:annotation>
    <xs:complexType>
      <xs:attribute name="RefLayerName" type="xs:string"
use="required">
        <xs:annotation>
          <xs:documentation>The LayerName value of the layer
found under StackupFile.EdaData.Stackup.Group.Layer that represent a
reference plan used during the impedance calculation.</xs:documentation>
        </xs:annotation>
      </xs:attribute>
    </xs:complexType>
  </xs:element>
</xs:sequence>
<xs:attribute name="LayerName" type="xs:string"
use="required">
  <xs:annotation>
    <xs:documentation>The Layer name used to reference the
specific Impedance Type.</xs:documentation>
  </xs:annotation>
</xs:attribute>
<xs:attribute name="Structure" type="Structure"
use="optional">
  <xs:annotation>
    <xs:documentation>Contains the impedance structure
definition in the area of stripline, microstrip or coplanar waveguided.</
xs:documentation>
  </xs:annotation>
</xs:attribute>
<xs:attribute name="ZoCalculatedOhms" type="xs:double"
use="optional">
  <xs:annotation>
    <xs:documentation>If the design source has an impedance
similator this would contain the calculated single-ended calculation
result for this impedance instance.</xs:documentation>
  </xs:annotation>
</xs:attribute>
</xs:complexType>
</xs:element>
<xs:element name="Differential_Coplanar_Waveguide"
minOccurs="0" maxOccurs="unbounded">
  <xs:annotation>

```

```
        <xs:documentation>A representation of a differential
Coplanar waveguided impedance requirement.</xs:documentation>
    </xs:annotation>
    <xs:complexType>
    <xs:sequence>
    <xs:element name="TraceWidth">
    <xs:annotation>
    <xs:documentation>Contains the desired trace width to
use for the target impedance.</xs:documentation>
    </xs:annotation>
    <xs:complexType>
    <xs:attribute name="Val" type="xs:double"
use="required">
    <xs:annotation>
    <xs:documentation>Contains the target trace width of
the related conductor.</xs:documentation>
    </xs:annotation>
    </xs:attribute>
    <xs:attribute name="Units" type="UnitsType"
use="optional" default="MIL">
    <xs:annotation>
    <xs:documentation>Contains the unit of measure used
for by the value in Val.</xs:documentation>
    </xs:annotation>
    </xs:attribute>
    <xs:attribute name="PlusVal" type="xs:double"
use="optional">
    <xs:annotation>
    <xs:documentation>A positive value representing the
plus tolerance value to added to the target trace (Val) with value.</
xs:documentation>
    </xs:annotation>
    </xs:attribute>
    <xs:attribute name="MinusVal" type="xs:double"
use="optional">
    <xs:annotation>
    <xs:documentation>A positive value representing the
negative tolerance value to subtracted from the target trace (Val) with
value.</xs:documentation>
    </xs:annotation>
    </xs:attribute>
    <xs:attribute name="TolPercent" type="xs:boolean"
use="optional" default="false">
    <xs:annotation>
    <xs:documentation>Trace width tolerance definition
- if true a percentage of Val, if false an absolute a value, to add or
subtracted fromVal.</xs:documentation>
    </xs:annotation>
    </xs:attribute>
    </xs:complexType>
    </xs:element>
    <xs:element name="Spacing">
    <xs:annotation>
    <xs:documentation>Contains the desired spacing between
copper for the target impedance.</xs:documentation>
    </xs:annotation>
    <xs:complexType>
    <xs:attribute name="Val" type="xs:double"
```

```
use="required">
    <xs:annotation>
    <xs:documentation>Contains the target spacing for
the related conductor. Default units is MIL.</xs:documentation>
    </xs:annotation>
    </xs:attribute>
    <xs:attribute name="Units" type="UnitsType"
use="optional" default="MIL">
    <xs:annotation>
    <xs:documentation>Contains the unit of measure used
for by the value in Val.</xs:documentation>
    </xs:annotation>
    </xs:attribute>
    </xs:complexType>
</xs:element>
<xs:element name="CoplanarSpacing">
    <xs:annotation>
    <xs:documentation>Contains the coplanar desired spacing
to use for the target impedance.</xs:documentation>
    </xs:annotation>
    <xs:complexType>
    <xs:attribute name="Val" type="xs:double"
use="required">
    <xs:annotation>
    <xs:documentation>Contains the target coplanar
spacing of the related conductor. Default units is MIL.</
xs:documentation>
    </xs:annotation>
    </xs:attribute>
    <xs:attribute name="Units" type="UnitsType"
use="optional" default="MIL">
    <xs:annotation>
    <xs:documentation>Contains the unit of measure used
for by the value in Val.</xs:documentation>
    </xs:annotation>
    </xs:attribute>
    </xs:complexType>
</xs:element>
<xs:element name="CoplanarTraceWidth" minOccurs="0">
    <xs:annotation>
    <xs:documentation>Contains the coplanar desired trace
width to use for the target impedance. In the case of reference a plane
this attribute is to not be defined.</xs:documentation>
    </xs:annotation>
    <xs:complexType>
    <xs:attribute name="Val" type="xs:double"
use="required">
    <xs:annotation>
    <xs:documentation>Contains the target trace width of
the related conductor. Default units is MIL.</xs:documentation>
    </xs:annotation>
    </xs:attribute>
    <xs:attribute name="Units" type="UnitsType"
use="optional" default="MIL">
    <xs:annotation>
    <xs:documentation>Contains the unit of measure used
for by the value in Val.</xs:documentation>
    </xs:annotation>
```

```
        </xs:attribute>
        <xs:attribute name="PlusVal" type="xs:double"
use="optional">
        <xs:annotation>
        <xs:documentation>A positive value representing the
plus tolerance value to added to the target trace (Val) with value.</
xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="MinusVal" type="xs:double"
use="optional">
        <xs:annotation>
        <xs:documentation>A positive value representing the
negative tolerance value to subtracted from the target trace (Val) with
value.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="TolPercent" type="xs:boolean"
use="optional" default="false">
        <xs:annotation>
        <xs:documentation>Trace width tolerance definition
- if true a percentage of Val, if false an absolute a value, to add or
subtracted fromVal.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        </xs:complexType>
    </xs:element>
    <xs:element name="RefPlane" minOccurs="0" maxOccurs="2">
    <xs:annotation>
    <xs:documentation>Contains the list of layer that
represent the reference planes used during the impedance calculation.</
xs:documentation>
    </xs:annotation>
    <xs:complexType>
    <xs:attribute name="RefLayerName" type="xs:string"
use="required">
    <xs:annotation>
    <xs:documentation>The LayerName value of the layer
found under StackupFile.EdaData.Stackup.Group.Layer that represent a
reference plan used during the impedance calculation.</xs:documentation>
    </xs:annotation>
    </xs:attribute>
    </xs:complexType>
    </xs:element>
    </xs:sequence>
    <xs:attribute name="LayerName" type="xs:string"
use="required">
    <xs:annotation>
    <xs:documentation>The Layer name used to reference the
specific Impedance Type.</xs:documentation>
    </xs:annotation>
    </xs:attribute>
    <xs:attribute name="Structure" type="Structure"
use="optional">
    <xs:annotation>
    <xs:documentation>Contains the impedance structure
definition in the area of stripline, microstrip or coplanar waveguided.</
xs:documentation>
```

```

        </xs:annotation>
      </xs:attribute>
      <xs:attribute name="ZoCalculatedOhms" type="xs:double"
use="optional">
        <xs:annotation>
          <xs:documentation>If the design source has an impedance
similator this would contain the calculated single-ended calculation
result for this impedance instance.</xs:documentation>
        </xs:annotation>
      </xs:attribute>
      <xs:attribute name="ZDiffCalculatedOhms" type="xs:double"
use="optional">
        <xs:annotation>
          <xs:documentation>If the design source has an impedance
similator this would contain the calculated differential calculation
result for this impedance instance.</xs:documentation>
        </xs:annotation>
      </xs:attribute>
      <xs:attribute name="InsertionLoss" type="xs:double"
use="optional">
        <xs:annotation>
          <xs:documentation>The resulting lost of single power.</
xs:documentation>
        </xs:annotation>
      </xs:attribute>
      <xs:attribute name="InsertionLossUnits"
type="InsertionLossType" use="optional" default="DB/INCH">
        <xs:annotation>
          <xs:documentation>Units for InsertionLoss. Default is
dB/Inch.</xs:documentation>
        </xs:annotation>
      </xs:attribute>
    </xs:complexType>
  </xs:element>
  <xs:element name="Differential_Edge_Coupled" minOccurs="0"
maxOccurs="unbounded">
    <xs:annotation>
      <xs:documentation>A representation of a differential edge
coupled impedance requirement.</xs:documentation>
    </xs:annotation>
    <xs:complexType>
      <xs:sequence>
        <xs:element name="TraceWidth">
          <xs:annotation>
            <xs:documentation>Contains the desired trace width to
use for the target impedance.</xs:documentation>
          </xs:annotation>
        </xs:complexType>
        <xs:attribute name="Val" type="xs:double"
use="required">
          <xs:annotation>
            <xs:documentation>Contains the target trace width of
the related conductor.</xs:documentation>
          </xs:annotation>
        </xs:attribute>
        <xs:attribute name="Units" type="UnitsType"
use="optional" default="MIL">
          <xs:annotation>

```

```
        <xs:documentation>Contains the unit of measure used
for by the value in Val.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="PlusVal" type="xs:double"
use="optional">
        <xs:annotation>
        <xs:documentation>A positive value representing the
plus tolerance value to added to the target trace (Val) with value.</
xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="MinusVal" type="xs:double"
use="optional">
        <xs:annotation>
        <xs:documentation>A positive value representing the
negative tolerance value to subtracted from the target trace (Val) with
value.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="TolPercent" type="xs:boolean"
use="optional" default="false">
        <xs:annotation>
        <xs:documentation>Trace width tolerance definition
- if true a percentage of Val, if false an absolute a value, to add or
subtracted fromVal.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        </xs:complexType>
    </xs:element>
    <xs:element name="Spacing">
        <xs:annotation>
        <xs:documentation>Contains the desired spacing between
copper for the target impedance.</xs:documentation>
        </xs:annotation>
        <xs:complexType>
        <xs:attribute name="Val" type="xs:double"
use="required">
        <xs:annotation>
        <xs:documentation>Contains the target spacing for
the related conductor.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="Units" type="UnitsType"
use="optional" default="MIL">
        <xs:annotation>
        <xs:documentation>Contains the unit of measure used
for by the value in Val.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        </xs:complexType>
    </xs:element>
    <xs:element name="RefPlane" minOccurs="0" maxOccurs="2">
        <xs:annotation>
        <xs:documentation>Contains the list of layer that
represent the reference planes used during the impedance calculation.</
xs:documentation>
        </xs:annotation>
```

```

        <xs:complexType>
        <xs:attribute name="RefLayerName" type="xs:string"
use="required">
        <xs:annotation>
        <xs:documentation>The LayerName value of the layer
found under StackupFile.EDAData.Stackup.Group.Layer that represent a
reference plan used during the impedance calculation.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        </xs:complexType>
        </xs:element>
</xs:sequence>
<xs:attribute name="LayerName" type="xs:string"
use="required">
        <xs:annotation>
        <xs:documentation>The Layer name used to reference the
specific Impedance Type.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
<xs:attribute name="Structure" type="Structure"
use="optional">
        <xs:annotation>
        <xs:documentation>Contains the impedance structure
definition in the area of stripline, microstrip or coplanar waveguided.</
xs:documentation>
        </xs:annotation>
        </xs:attribute>
<xs:attribute name="ZoCalculatedOhms" type="xs:double"
use="optional">
        <xs:annotation>
        <xs:documentation>If the design source has an impedance
simulator this would contain the calculated single-ended calculation
result for this impedance instance.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
<xs:attribute name="ZDiffCalculatedOhms" type="xs:double"
use="optional">
        <xs:annotation>
        <xs:documentation>If the design source has an impedance
simulator this would contain the calculated differential calculation
result for this impedance instance.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
<xs:attribute name="InsertionLoss" type="xs:double"
use="optional">
        <xs:annotation>
        <xs:documentation>The resulting lost of single power.</
xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="InsertionLossUnits"
type="InsertionLossType" use="optional" default="DB/INCH">
        <xs:annotation>
        <xs:documentation>Units for InsertionLoss. Default is
dB/Inch.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
</xs:complexType>

```



```
</xs:element>
<xs:element name="Single_Ended_Coplanar_Waveguide"
minOccurs="0" maxOccurs="unbounded">
  <xs:annotation>
    <xs:documentation>A representation of a single-ended
Coplanar waveguided impedance requirement.</xs:documentation>
  </xs:annotation>
  <xs:complexType>
    <xs:sequence>
      <xs:element name="TraceWidth">
        <xs:annotation>
          <xs:documentation>Contains the desired trace width to
use for the target impedance.</xs:documentation>
        </xs:annotation>
        <xs:complexType>
          <xs:attribute name="Val" type="xs:double"
use="required">
            <xs:annotation>
              <xs:documentation>Contains the target trace width of
the related conductor.</xs:documentation>
            </xs:annotation>
            </xs:attribute>
            <xs:attribute name="Units" type="UnitsType"
use="optional" default="MIL">
              <xs:annotation>
                <xs:documentation>Contains the unit of measure used
for by the value in Val.</xs:documentation>
              </xs:annotation>
              </xs:attribute>
              <xs:attribute name="PlusVal" type="xs:double"
use="optional">
                <xs:annotation>
                  <xs:documentation>A positive value representing the
plus tolerance value to added to the target trace (Val) with value.</
xs:documentation>
                </xs:annotation>
                </xs:attribute>
                <xs:attribute name="MinusVal" type="xs:double"
use="optional">
                  <xs:annotation>
                    <xs:documentation>A positive value representing the
negative tolerance value to subtracted from the target trace (Val) with
value.</xs:documentation>
                  </xs:annotation>
                  </xs:attribute>
                  <xs:attribute name="TolPercent" type="xs:boolean"
use="optional" default="false">
                    <xs:annotation>
                      <xs:documentation>Trace width tolerance definition
- if true a percentage of Val, if false an absolute a value, to add or
subtracted fromVal.</xs:documentation>
                    </xs:annotation>
                    </xs:attribute>
                  </xs:complexType>
                </xs:element>
              <xs:element name="CoplanarSpacing">
                <xs:annotation>
                  <xs:documentation>Contains the desired spacing between
```

```

copper for the target impedance.</xs:documentation>
    </xs:annotation>
    <xs:complexType>
        <xs:attribute name="Val" type="xs:double"
use="required">
            <xs:annotation>
                <xs:documentation>Contains the target spacing for
the related conductor.</xs:documentation>
            </xs:annotation>
            </xs:attribute>
            <xs:attribute name="Units" type="UnitsType"
use="optional" default="MIL">
                <xs:annotation>
                    <xs:documentation>Contains the unit of measure used
for by the value in Val.</xs:documentation>
                </xs:annotation>
                </xs:attribute>
            </xs:complexType>
        </xs:element>
        <xs:element name="CoplanarTraceWidth" minOccurs="0">
            <xs:annotation>
                <xs:documentation>Contains the coplanar desired trace
width to use for the target impedance. In the case of reference a plane
this attribute is to not be defined.</xs:documentation>
            </xs:annotation>
            <xs:complexType>
                <xs:attribute name="Val" type="xs:double"
use="required">
                    <xs:annotation>
                        <xs:documentation>Contains the target trace width of
the related conductor.</xs:documentation>
                    </xs:annotation>
                    </xs:attribute>
                    <xs:attribute name="Units" type="UnitsType"
use="optional" default="MIL">
                        <xs:annotation>
                            <xs:documentation>Contains the unit of measure used
for by the value in Val.</xs:documentation>
                        </xs:annotation>
                        </xs:attribute>
                    <xs:attribute name="PlusVal" type="xs:double"
use="optional">
                        <xs:annotation>
                            <xs:documentation>A positive value representing the
plus tolerance value to added to the target trace (Val) with value.</
xs:documentation>
                        </xs:annotation>
                        </xs:attribute>
                    <xs:attribute name="MinusVal" type="xs:double"
use="optional">
                        <xs:annotation>
                            <xs:documentation>A positive value representing the
negative tolerance value to subtracted from the target trace (Val) with
value.</xs:documentation>
                        </xs:annotation>
                        </xs:attribute>
                    <xs:attribute name="TolPercent" type="xs:boolean"
use="optional" default="false">

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        <xs:annotation>
        <xs:documentation>Trace width tolerance definition
- if true a percentage of Val, if false an absolute a value, to add or
substracted fromVal.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
    </xs:complexType>
</xs:element>
<xs:element name="RefPlane" minOccurs="0" maxOccurs="2">
    <xs:annotation>
    <xs:documentation>Contains the list of layer that
represent the reference planes used during the impedance calculation.</
xs:documentation>
    </xs:annotation>
    <xs:complexType>
        <xs:attribute name="RefLayerName" type="xs:string"
use="required">
            <xs:annotation>
            <xs:documentation>The LayerName value of the layer
found under StackupFile.EdaData.Stackup.Group.Layer that represent a
reference plan used during the impedance calculation.</xs:documentation>
            </xs:annotation>
            </xs:attribute>
        </xs:complexType>
    </xs:element>
</xs:sequence>
    <xs:attribute name="LayerName" type="xs:string"
use="required">
        <xs:annotation>
        <xs:documentation>The Layer name used to reference the
specific Impedance Type.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
    <xs:attribute name="Structure" type="Structure"
use="optional">
        <xs:annotation>
        <xs:documentation>Contains the impedance structure
definition in the area of stripline, microstrip or coplanar waveguided.</
xs:documentation>
        </xs:annotation>
        </xs:attribute>
    <xs:attribute name="ZoCalculatedOhms" type="xs:double"
use="optional">
        <xs:annotation>
        <xs:documentation>If the design source has an impedance
simulator this would contain the calculated single-ended calculation
result for this impedance instance.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
    <xs:attribute name="ZDiffCalculatedOhms" type="xs:double"
use="optional">
        <xs:annotation>
        <xs:documentation>If the design source has an impedance
simulator this would contain the calculated differential calculation
result for this impedance instance.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
    </xs:complexType>
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        </xs:element>
        <xs:element name="Differential_Broadside_Coupled"
minOccurs="0" maxOccurs="unbounded">
        <xs:annotation>
        <xs:documentation>A representation of a differential
broadshide coupled impedance requirement.</xs:documentation>
        </xs:annotation>
        <xs:complexType>
        <xs:sequence>
        <xs:element name="TraceWidth">
        <xs:annotation>
        <xs:documentation>Contains the desired trace width to
use for the target impedance.</xs:documentation>
        </xs:annotation>
        <xs:complexType>
        <xs:attribute name="Val" type="xs:double"
use="required">
        <xs:annotation>
        <xs:documentation>Contains the target trace width of
the related conductor.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="Units" type="UnitsType"
use="optional" default="MIL">
        <xs:annotation>
        <xs:documentation>Contains the unit of measure used
for by the value in Val.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="PlusVal" type="xs:double"
use="optional">
        <xs:annotation>
        <xs:documentation>A positive value representing the
plus tolerance value to added to the target trace (Val) with value.</
xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="MinusVal" type="xs:double"
use="optional">
        <xs:annotation>
        <xs:documentation>A positive value representing the
negative tolerance value to subtracted from the target trace (Val) with
value.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="TolPercent" type="xs:boolean"
use="optional" default="false">
        <xs:annotation>
        <xs:documentation>Trace width tolerance definition
- if true a percentage of Val, if false an absolute a value, to add or
substracted fromVal.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        </xs:complexType>
        </xs:element>
        <xs:element name="TraceSeparation">
        <xs:annotation>
        <xs:documentation>Contains the desired distance between

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the related conductors.</xs:documentation>
    </xs:annotation>
    <xs:complexType>
      <xs:attribute name="Val" type="xs:double"
use="required">
        <xs:annotation>
          <xs:documentation>Contains the target separation
between of the related conductor. Default unit is MIL.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="Units" type="UnitsType"
use="optional" default="MIL">
          <xs:annotation>
            <xs:documentation>Contains the unit of measure used
for by the value in Val.</xs:documentation>
          </xs:annotation>
          </xs:attribute>
          <xs:attribute name="IsPitch" type="xs:boolean"
use="optional" default="true">
            <xs:annotation>
              <xs:documentation>Trace Separation definitiion - if
true the spacing between the conductors are measured from center line to
center line or pitch, if false a value for the spacing is edge to edge of
the conductors.</xs:documentation>
            </xs:annotation>
            </xs:attribute>
          </xs:complexType>
        </xs:element>
      <xs:element name="RefPlane" minOccurs="0" maxOccurs="2">
        <xs:annotation>
          <xs:documentation>Contains the list of layer that
represent the reference planes used during the impedance calculation.</
xs:documentation>
        </xs:annotation>
        <xs:complexType>
          <xs:attribute name="RefLayerName" type="xs:string"
use="required">
            <xs:annotation>
              <xs:documentation>The LayerName value of the layer
found under StackupFile.EdaData.Stackup.Group.Layer that represent a
reference plan used during the impedance calculation.</xs:documentation>
            </xs:annotation>
            </xs:attribute>
          </xs:complexType>
        </xs:element>
      </xs:sequence>
      <xs:attribute name="LayerName" type="xs:string"
use="required">
        <xs:annotation>
          <xs:documentation>The Layer name used to reference the
specific Impedance Type.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="Structure" type="Structure"
use="optional">
          <xs:annotation>
            <xs:documentation>Contains the impedance structure
definition in the area of stripline, microstrip or coplanar waveguided.</
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xs:documentation>
    </xs:annotation>
    </xs:attribute>
    <xs:attribute name="ZoCalculatedOhms" type="xs:double"
use="optional">
    <xs:annotation>
    <xs:documentation>If the design source has an impedance
simulator this would contain the calculated single-ended calculation
result for this impedance instance.</xs:documentation>
    </xs:annotation>
    </xs:attribute>
    <xs:attribute name="ZDiffCalculatedOhms" type="xs:double"
use="optional">
    <xs:annotation>
    <xs:documentation>If the design source has an impedance
simulator this would contain the calculated differential calculation
result for this impedance instance.</xs:documentation>
    </xs:annotation>
    </xs:attribute>
    <xs:attribute name="InsertionLoss" type="xs:double"
use="optional">
    <xs:annotation>
    <xs:documentation>The resulting lost of single power.</
xs:documentation>
    </xs:annotation>
    </xs:attribute>
    <xs:attribute name="InsertionLossUnits"
type="InsertionLossType" use="optional" default="DB/INCH">
    <xs:annotation>
    <xs:documentation>Units for InsertionLoss. Default is
dB/Inch.</xs:documentation>
    </xs:annotation>
    </xs:attribute>
    </xs:complexType>
    </xs:element>
    </xs:sequence>
    <xs:attribute name="ImpName" type="xs:string"
use="required">
    <xs:annotation>
    <xs:documentation>The name used to reference the specific
Impedance.</xs:documentation>
    </xs:annotation>
    </xs:attribute>
    <xs:attribute name="ZoValOhms" type="xs:double"
use="optional">
    <xs:annotation>
    <xs:documentation>Single-ended impedance target value in
Ohms.</xs:documentation>
    </xs:annotation>
    </xs:attribute>
    <xs:attribute name="ZoPlusVal" type="xs:double"
use="optional">
    <xs:annotation>
    <xs:documentation>A positive value representing the plus
value to add to the target single-ended impedance value ZoValOhms.
(tolerance) Use of ZoPlusVal determined by the ZoValPercent value.</
xs:documentation>
    </xs:annotation>

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        </xs:attribute>
        <xs:attribute name="ZoMinusVal" type="xs:double"
use="optional">
        <xs:annotation>
        <xs:documentation>A positive value representing the plus
value to subtract from the target single-ended impedance value ZoValOhms.
(tolerance) Use of ZoPMinusVal determined by the ZoValPercent value.</
xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="ZoValPercent" type="xs:boolean"
use="optional" default="true">
        <xs:annotation>
        <xs:documentation>Single-ended tolerance definitiion - if
true a percentage of ZoValOhms, if false an absolute a value to add or
substract from ZoValOhms.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="ZDiffValOhms" type="xs:double"
use="optional">
        <xs:annotation>
        <xs:documentation>Differential impedance target value in
Ohms.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="ZDiffPlusVal" type="xs:double"
use="optional">
        <xs:annotation>
        <xs:documentation>A positive value representing the plus
value to add to the target differential impedance value ZDiffValOhms.
(tolerance) Use of ZDiffPlusVal determined by the ZDiffValPercent value.</
xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="ZDiffMinusVal" type="xs:double"
use="optional">
        <xs:annotation>
        <xs:documentation>A positive value representing the plus
value to subtract from the target differential impedance value
ZDiffValOhms. (tolerance) Use of ZDiffMinusVal determined by the
ZDiffValPercent value.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="ZDiffValPercent" type="xs:boolean"
use="optional" default="true">
        <xs:annotation>
        <xs:documentation>Differential tolerance definitiion - if
true a percentage of ZDiffValOhms, if false an absolute a value, to add or
substract from ZDiffValOhms.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
    </xs:complexType>
</xs:element>
</xs:sequence>
<xs:attribute name="SpecName" type="xs:string" use="required">
    <xs:annotation>
    <xs:documentation>The name used to reference the specific
Spec.</xs:documentation>
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        </xs:annotation>
      </xs:attribute>
    </xs:complexType>
  </xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
<xs:element name="Stackup">
  <xs:annotation>
    <xs:documentation>Contains the stackup representation as
delivered by the design source.</xs:documentation>
  </xs:annotation>
  <xs:complexType>
    <xs:sequence>
      <xs:element name="Group" maxOccurs="unbounded">
        <xs:annotation>
          <xs:documentation>A stackup is created by mutliple Group which
is comprised of a collection of Materials with condutor materials tied to
copper layers of the design. The series is represented from the top of
the design to the bottom.</xs:documentation>
        </xs:annotation>
        <xs:complexType>
          <xs:sequence>
            <xs:element name="Layer" maxOccurs="unbounded">
              <xs:annotation>
                <xs:documentation>A layer definition within the Group.</
xs:documentation>
              </xs:annotation>
              <xs:complexType>
                <xs:sequence>
                  <xs:element name="SpecRef" minOccurs="0"
maxOccurs="unbounded">
                    <xs:annotation>
                      <xs:documentation>The list Material and Impedance Specs
and conductor requirements for a layer.</xs:documentation>
                    </xs:annotation>
                    <xs:complexType>
                      <xs:sequence>
                        <xs:element name="Material" minOccurs="0">
                          <xs:annotation>
                            <xs:documentation>Defines the Material requirements
for a layer.</xs:documentation>
                          </xs:annotation>
                          <xs:complexType>
                            <xs:attribute name="MaterialName" type="xs:string"
use="required">
                              <xs:annotation>
                                <xs:documentation>The name used for referencing the
designated Material within the referenced SpecName.</xs:documentation>
                              </xs:annotation>
                              </xs:attribute>
                              <xs:attribute name="PropertyName" type="xs:string"
use="optional">
                                <xs:annotation>
                                  <xs:documentation>The name used for referencing the
designated Properties within the referenced Material. If there is only
one Property defined then that will be considered the default and the
existence of the attribute FrequencyVal not required.</xs:documentation>

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        </xs:annotation>
      </xs:attribute>
      <xs:attribute name="FrequencyVal" type="xs:double"
use="optional">
        <xs:annotation>
          <xs:documentation>Contains the frequency of the
signal on the net. Could be used to reference additional material content
when used as a reference into PropertyName. If there is only one Property
defined then that will be considered the default and the existence of the
attribute is not required.</xs:documentation>
        </xs:annotation>
      </xs:attribute>
      <xs:attribute name="CopperAreaPrecent"
type="xs:double" use="optional">
        <xs:annotation>
          <xs:documentation>A percentage calculated by finding
the copper area of a layer and dividing that by the total area of layer
laminiate.</xs:documentation>
        </xs:annotation>
      </xs:attribute>
      <xs:attribute name="TraceWidthTop" type="xs:double"
use="optional">
        <xs:annotation>
          <xs:documentation>The etching of copper is
trapezoidal ends with the top of the copper is narrower than the bottom.
This attribute contains the width of the top of a trace located on the
design. If not present then the value found in TraceWidthBottom is assume
as a starting point. The default unit of measure is governed by
StackupFile->DefaultUnits which is by default MIL.</xs:documentation>
        </xs:annotation>
      </xs:attribute>
      <xs:attribute name="TraceWidthBottom" type="xs:double"
use="optional">
        <xs:annotation>
          <xs:documentation>The etching of copper is
trapezoidal ends with the top of the copper is narrower than the bottom.
This attribute contains the width of the bottom of a trace located on the
design. For conductor layer types this value is required. The default
unit of measure is governed by StackupFile->DefaultUnits which is by
default MIL.</xs:documentation>
        </xs:annotation>
      </xs:attribute>
      <xs:attribute name="Units_TraceWidth" type="UnitsType"
use="optional" default="MIL">
        <xs:annotation>
          <xs:documentation>The unit value that the
TraceWidthTop and TraceWidthBottom attributes are to be measured in. </
xs:documentation>
        </xs:annotation>
      </xs:attribute>
    </xs:complexType>
  </xs:element>
  <xs:element name="Impedance" minOccurs="0">
    <xs:annotation>
      <xs:documentation>Defines the Impedance requirements
for a layer.</xs:documentation>
    </xs:annotation>
  </xs:complexType>
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        <xs:attribute name="ImpName" type="xs:string"
use="required">
        <xs:annotation>
        <xs:documentation>The name used for referencing the
designated Impedance.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="ImpTypeName" type="ImpedanceType"
use="required">
        <xs:annotation>
        <xs:documentation>The type of impedance to use within
the designated Impedance.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        </xs:complexType>
        </xs:element>
        </xs:sequence>
        <xs:attribute name="MaterialSpecName" type="xs:string"
use="required">
        <xs:annotation>
        <xs:documentation>The name used for referencing the
selected Material Spec.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="ImpSpecName" type="xs:string"
use="optional">
        <xs:annotation>
        <xs:documentation>The name used for referencing the
selected Impedance Spec.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        </xs:complexType>
        </xs:element>
        </xs:sequence>
        <xs:attribute name="LayerName" type="xs:string"
use="required">
        <xs:annotation>
        <xs:documentation>A name of layer used within the
design.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="LayerType" type="LayerType"
use="optional" default="DOCUMENT">
        <xs:annotation>
        <xs:documentation>An enumerated list of layer type
representing the purpose behind the layer. Default is DOCUMENT.</
xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="LayerSubType" type="LayerSubType"
use="optional">
        <xs:annotation>
        <xs:documentation>An enumerated list of sub layer type
when used to further refine the meaning behind the value found it
LayerType. For example, a LayerType DRILL with a SubType BACKDRILL.</
xs:documentation>
        </xs:annotation>
        </xs:attribute>

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        <xs:attribute name="MechStartLayerName" type="xs:string"
use="optional">
        <xs:annotation>
        <xs:documentation>In the event LayerType has the value of
DRILL or ROUT, this attribute value represents the beginning layer named
where the material in mechanically penetrated.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="MechEndLayerName" type="xs:string"
use="optional">
        <xs:annotation>
        <xs:documentation>In the event LayerType has the value of
DRILL or ROUT, this attribute value represents the final layer named where
the material in mechanically penetrated.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="Side" type="SideType" use="optional"
default="NONE">
        <xs:annotation>
        <xs:documentation>An enumerated list of a value declaring
the relative position of the layer within the stackup. Default is NONE.</
xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="Description" type="xs:string"
use="optional">
        <xs:annotation>
        <xs:documentation>Open description from the deisgn company
of the originating layer.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="Comment" type="xs:string"
use="optional">
        <xs:annotation>
        <xs:documentation>Open comment from the design company of
the originating layer.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        </xs:complexType>
    </xs:element>
</xs:sequence>
    <xs:attribute name="GroupName" type="xs:string" use="required">
    <xs:annotation>
    <xs:documentation>The name used to reference the Group.</
xs:documentation>
    </xs:annotation>
    </xs:attribute>
    <xs:attribute name="GroupThickness" type="xs:double"
use="optional">
    <xs:annotation>
    <xs:documentation>The total thickness for the group of
layers. Default unit is MIL.</xs:documentation>
    </xs:annotation>
    </xs:attribute>
    <xs:attribute name="Units" type="UnitsType" use="optional"
default="MIL">
    <xs:annotation>
    <xs:documentation>The unit value that the GroupThickness
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attribute are to be measured in. The default unit of measure is governed
by StackupFile->DefaultUnits which is by default MIL.</xs:documentation>
</xs:annotation>
</xs:attribute>
<xs:attribute name="NumberOfLaminateCycles" type="xs:integer"
use="optional">
  <xs:annotation>
    <xs:documentation>Total number of lamination cycles the group
of layers will be subjected to from the beginning to the end of the
booking process.</xs:documentation>
  </xs:annotation>
</xs:attribute>
</xs:complexType>
</xs:element>
</xs:sequence>
<xs:attribute name="StackupName" type="xs:string" use="required">
  <xs:annotation>
    <xs:documentation>The name used to reference the Stackup.</
xs:documentation>
  </xs:annotation>
</xs:attribute>
<xs:attribute name="StackupThickness" type="xs:double"
use="required">
  <xs:annotation>
    <xs:documentation>The target board thickness. Default unit is
MIL.</xs:documentation>
  </xs:annotation>
</xs:attribute>
<xs:attribute name="PlusTol" type="xs:double" use="optional">
  <xs:annotation>
    <xs:documentation>A positive value representing the plus value
to add to the target stackup thickness StackupThickness</xs:documentation>
  </xs:annotation>
</xs:attribute>
<xs:attribute name="MinusTol" type="xs:double" use="optional">
  <xs:annotation>
    <xs:documentation>A positive value representing the negative
value to subtracted from the target stackup thickness StackupThickness</
xs:documentation>
  </xs:annotation>
</xs:attribute>
<xs:attribute name="Units" type="UnitsType" use="optional"
default="MIL">
  <xs:annotation>
    <xs:documentation>The unit value that the StackupThickness,
PlusTol and MinusTol attributes are to be measured in. The default unit
of measure is governed by StackupFile->DefaultUnits which is by default
MIL.</xs:documentation>
  </xs:annotation>
</xs:attribute>
<xs:attribute name="WhereMeasured" type="WhereMeasured"
use="optional" default="METAL">
  <xs:annotation>
    <xs:documentation>An enumerated value of where the
StackupThickness is measured from.</xs:documentation>
  </xs:annotation>
</xs:attribute>
<xs:attribute name="TotalLaminationCycles" type="xs:integer">
```

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use="optional">
  <xs:annotation>
    <xs:documentation>Total number of lamination cycles required to
complete the booking process.</xs:documentation>
  </xs:annotation>
</xs:attribute>
</xs:complexType>
</xs:element>
</xs:sequence>
<xs:attribute name="CompanyName" type="xs:string" use="required">
  <xs:annotation>
    <xs:documentation>The name of the design company of the originating
stackup.</xs:documentation>
  </xs:annotation>
</xs:attribute>
<xs:attribute name="ContactName" type="xs:string" use="optional">
  <xs:annotation>
    <xs:documentation>The name of the contact of the originating
stackup.</xs:documentation>
  </xs:annotation>
</xs:attribute>
<xs:attribute name="Address" type="xs:string" use="optional">
  <xs:annotation>
    <xs:documentation>The postal address of the deisgn company of the
originating stackup.</xs:documentation>
  </xs:annotation>
</xs:attribute>
<xs:attribute name="PhoneNumber" type="xs:string" use="optional">
  <xs:annotation>
    <xs:documentation>The phone number of the deisgn company of the
originating stackup.</xs:documentation>
  </xs:annotation>
</xs:attribute>
<xs:attribute name="Comment" type="xs:string" use="optional">
  <xs:annotation>
    <xs:documentation>Open comment from the design company of the
originating stackup.</xs:documentation>
  </xs:annotation>
</xs:attribute>
</xs:complexType>
</xs:element>
<xs:element name="SupplierData" minOccurs="0" maxOccurs="unbounded">
  <xs:annotation>
    <xs:documentation>Represents instances of a manufacturing stackup
each with the required content deteremined by suppliers. It should
contain a full stackup defining the final materials and impedance
calculation based the material of use.</xs:documentation>
  </xs:annotation>
<xs:complexType>
  <xs:sequence>
    <xs:element name="Specs">
      <xs:annotation>
        <xs:documentation>Contains a list of specification (Spec) of
material used during stack design and impedance requirements.</
xs:documentation>
      </xs:annotation>
    <xs:complexType>
      <xs:sequence>
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        <xs:element name="Spec" maxOccurs="unbounded">
            <xs:annotation>
                <xs:documentation>An individual Spec defining a collection of
materials and impedance requirements. The Spec is select later through
the use of the SpecName attribute.</xs:documentation>
            </xs:annotation>
            <xs:complexType>
                <xs:sequence>
                    <xs:element name="Material" minOccurs="0"
maxOccurs="unbounded">
                        <xs:annotation>
                            <xs:documentation>A Material specficiation defining a
specific material, dielectric or conductor. The Material is select later
through the use of the MaterialName attribute.</xs:documentation>
                        </xs:annotation>
                        <xs:complexType>
                            <xs:sequence>
                                <xs:element name="Dielectric" minOccurs="0">
                                    <xs:annotation>
                                        <xs:documentation>A definition of a specific piece of
dielectric material. </xs:documentation>
                                    </xs:annotation>
                                    <xs:complexType>
                                        <xs:sequence>
                                            <xs:element name="Properties" minOccurs="0"
maxOccurs="unbounded">
                                                <xs:annotation>
                                                    <xs:documentation>Contains a list of Frequencies
related to the material behavior. Material's electrical characteristics
are influenced by the frequency of the impedance net.The Frequencies is
selected later through the use of the FrequencyName attribute.</
xs:documentation>
                                                </xs:annotation>
                                                <xs:complexType>
                                                    <xs:sequence>
                                                        <xs:element name="Property" maxOccurs="unbounded">
                                                            <xs:annotation>
                                                                <xs:documentation>A specific frequency and the
related electrical characteristics.</xs:documentation>
                                                            </xs:annotation>
                                                            <xs:complexType>
                                                                <xs:attribute name="FrequencyVal" type="xs:double"
use="optional">
                                                                    <xs:annotation>
                                                                        <xs:documentation>The value of the single
frequency. Default is GHz.</xs:documentation>
                                                                    </xs:annotation>
                                                                    </xs:attribute>
                                                                <xs:attribute name="Units" type="FrequencyType"
use="optional" default="GHz">
                                                                    <xs:annotation>
                                                                        <xs:documentation>The unit of the FrequenceVal
frequency.</xs:documentation>
                                                                    </xs:annotation>
                                                                    </xs:attribute>
                                                                <xs:attribute name="DielectricConstant_Dk"
type="xs:double" use="optional">
                                                                    <xs:annotation>

```

```

        <xs:documentation>The Dielectric Constant (DK) at
the specified FrequencyVal frequency.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="LossTangent_Df" type="xs:double"
use="optional">
            <xs:annotation>
                <xs:documentation>The Loss Tangent (Df) at the
specified FrequencyVal frequency.</xs:documentation>
            </xs:annotation>
            </xs:attribute>
            <xs:attribute name="Thickness" type="xs:double"
use="optional">
                <xs:annotation>
                    <xs:documentation>The overriding thickness of the
dielectric material. The default unit of measure is governed by
StackupFile->DefaultUnits which is by default MIL.</xs:documentation>
                </xs:annotation>
                </xs:attribute>
                <xs:attribute name="Finished_Thickness"
type="xs:double" use="optional">
                    <xs:annotation>
                        <xs:documentation>The overriding finished
thickness of the dielectric material. The default unit of measure is
governed by StackupFile->DefaultUnits which is by default MIL.</
xs:documentation>
                    </xs:annotation>
                    </xs:attribute>
                    <xs:attribute name="Units_Thickness"
type="UnitsType" use="optional" default="MIL">
                        <xs:annotation>
                            <xs:documentation>The unit value that the
Thickness and Finished_Thickness attribute is to be measured in. The
default unit of measure is governed by StackupFile->DefaultUnits which is
by default MIL.</xs:documentation>
                        </xs:annotation>
                        </xs:attribute>
                    </xs:complexType>
                </xs:element>
            </xs:sequence>
            <xs:attribute name="PropertyName" type="xs:string"
use="required">
                <xs:annotation>
                    <xs:documentation>The name used to reference the
specific Frequency.</xs:documentation>
                </xs:annotation>
                </xs:attribute>
            </xs:complexType>
        </xs:element>
        </xs:sequence>
        <xs:attribute name="DielectricType" type="DielectricType"
use="required">
            <xs:annotation>
                <xs:documentation>Defines the generic type of
dielectric materials, prepreg or core or other.</xs:documentation>
            </xs:annotation>
            </xs:attribute>
            <xs:attribute name="OtherSubType" type="OtherType"
```

```
use="optional">
    <xs:annotation>
        <xs:documentation>A list of material definition that
will most often be used when the DielectricType is OTHER.</
xs:documentation>
    </xs:annotation>
</xs:attribute>
<xs:attribute name="MaterialReference" type="xs:string"
use="optional">
    <xs:annotation>
        <xs:documentation>A free string of text that provides
the material suppliers reference name.</xs:documentation>
    </xs:annotation>
</xs:attribute>
<xs:attribute name="GlassStyle_Construction"
type="xs:string" use="optional">
    <xs:annotation>
        <xs:documentation>A free string of text that description
the Prepreg glass or Core construction.</xs:documentation>
    </xs:annotation>
</xs:attribute>
<xs:attribute name="ResinContent_Percent"
type="xs:double" use="optional">
    <xs:annotation>
        <xs:documentation>The percentage of resin found in the
dielectric material.</xs:documentation>
    </xs:annotation>
</xs:attribute>
<xs:attribute name="Description" type="xs:string"
use="optional">
    <xs:annotation>
        <xs:documentation>Open description regarding the
dielectric material.</xs:documentation>
    </xs:annotation>
</xs:attribute>
<xs:attribute name="Comment" type="xs:string"
use="optional">
    <xs:annotation>
        <xs:documentation>Open comment regarding the
dielectric material.</xs:documentation>
    </xs:annotation>
</xs:attribute>
</xs:complexType>
</xs:element>
<xs:element name="Conductor" minOccurs="0">
    <xs:annotation>
        <xs:documentation>A definition of a specific piece of
conductive material. </xs:documentation>
    </xs:annotation>
<xs:complexType>
    <xs:sequence>
        <xs:element name="Properties" minOccurs="0"
maxOccurs="unbounded">
            <xs:annotation>
                <xs:documentation>Contains a list of Properties related
to the material behavior. The Property is selected later through the use
of the PropertyName attribute.</xs:documentation>
            </xs:annotation>
```



```
<xs:complexType>
  <xs:sequence>
    <xs:element name="PropertyName">
      <xs:annotation>
        <xs:documentation>A specific property and the
related material characteristics.</xs:documentation>
      </xs:annotation>
      <xs:complexType>
        <xs:attribute name="Conductivity_mho_cm"
type="xs:double" use="optional">
          <xs:annotation>
            <xs:documentation>The Conductivity of the copper
measured in MHO/CM.</xs:documentation>
          </xs:annotation>
          </xs:attribute>
          <xs:attribute name="SurfaceRoughnessFacingCore_Rz"
type="xs:double" use="optional">
            <xs:annotation>
              <xs:documentation>In core materials the surface
roughness of the copper facing the core measured in Rz.</xs:documentation>
            </xs:annotation>
            </xs:attribute>
            <xs:attribute
name="SurfaceRoughnessFacingPrepreg_Rz" type="xs:decimal" use="optional">
              <xs:annotation>
                <xs:documentation>In core materials the surface
roughness of the copper facing the prepreg measured in Rz.</
xs:documentation>
              </xs:annotation>
              </xs:attribute>
              <xs:attribute name="SurfaceRoughnessFoil_Rz"
type="xs:double" use="optional">
                <xs:annotation>
                  <xs:documentation>For copper foil or sheet
materials the surface roughness measured in Rz.</xs:documentation>
                </xs:annotation>
                </xs:attribute>
                <xs:attribute name="DielectricConstant_Dk"
type="xs:double" use="optional">
                  <xs:annotation>
                    <xs:documentation>The Dielectric Constant (DK)
contributed to the resin during the lamination process.</xs:documentation>
                  </xs:annotation>
                  </xs:attribute>
                  <xs:attribute name="LossTangent_Df" type="xs:double"
use="optional">
                    <xs:annotation>
                      <xs:documentation>The Loss Tangent (Df) at the
scontributed to the resin during the lamination process.</
xs:documentation>
                    </xs:annotation>
                    </xs:attribute>
                    <xs:attribute name="Thickness" type="xs:double"
use="optional">
                      <xs:annotation>
                        <xs:documentation>The overriding thickness of the
conductor material. The default unit of measure is governed by
StackupFile->DefaultUnits which is by default MIL.</xs:documentation>
```

```

        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="Finished_Thickness"
type="xs:double" use="optional">
        <xs:annotation>
        <xs:documentation>The overriding finished
thickness of the conductor material. The default unit of measure is
governed by StackupFile->DefaultUnits which is by default MIL.</
xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="Units_Thickness"
type="UnitsType" use="optional" default="MIL"/>
        </xs:complexType>
        </xs:element>
        </xs:sequence>
        <xs:attribute name="PropertyName" type="xs:string"
use="required">
        <xs:annotation>
        <xs:documentation>The name used to reference the
specific set of Properties.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        </xs:complexType>
        </xs:element>
        </xs:sequence>
        <xs:attribute name="ConductorType" type="ConductorType"
use="required">
        <xs:annotation>
        <xs:documentation>The type of conductor. The values
are COPPER or OTHER.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="CopperWeight_oz_ft2" type="xs:double"
use="optional">
        <xs:annotation>
        <xs:documentation>This is mainly a historical means to
specify copper thickness. The intended value to be used in this case is
Thickness located just under Material.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="Description" type="xs:string"
use="optional">
        <xs:annotation>
        <xs:documentation>Open description regarding the
conductive material.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="Comment" type="xs:string"
use="optional">
        <xs:annotation>
        <xs:documentation>Open comment regarding the
conductive material.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        </xs:complexType>
        </xs:element>
        <xs:element name="Default_Thickness">
```

```
<xs:annotation>
  <xs:documentation>A definition of the dielectric or
conductor material supplier delivered thickness.</xs:documentation>
</xs:annotation>
<xs:complexType>
  <xs:attribute name="Thickness" type="xs:double"
use="required">
    <xs:annotation>
      <xs:documentation>The default thickness of the
dielectric or conductor material. The default unit of measure is governed
by StackupFile->DefaultUnits which is by default MIL.</xs:documentation>
    </xs:annotation>
    </xs:attribute>
    <xs:attribute name="Finished_Thickness" type="xs:double"
use="optional">
      <xs:annotation>
        <xs:documentation>The default finished thickness of the
dielectric or conductor material. The default unit of measure is governed
by StackupFile->DefaultUnits which is by default MIL.</xs:documentation>
      </xs:annotation>
      </xs:attribute>
      <xs:attribute name="Units" type="UnitsType"
use="optional" default="MIL">
        <xs:annotation>
          <xs:documentation>The unit value that the Thickness and
Finished_Thickness attribute is to be measured in. The default unit of
measure is governed by StackupFile->DefaultUnits which is by default
MIL.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
      </xs:complexType>
    </xs:element>
  </xs:sequence>
  <xs:attribute name="MaterialName" type="xs:string"
use="required">
    <xs:annotation>
      <xs:documentation>The name used to reference the specific
Material.</xs:documentation>
    </xs:annotation>
    </xs:attribute>
  </xs:complexType>
</xs:element>
<xs:element name="Impedance" minOccurs="0"
maxOccurs="unbounded">
  <xs:annotation>
    <xs:documentation>A Impedance specficiation defining the
general impedance goal and then the physical characteristics. The
Impedance is select later through the use of the ImplName attribute.</
xs:documentation>
  </xs:annotation>
  <xs:complexType mixed="true">
    <xs:sequence>
      <xs:element name="Single_Ended" minOccurs="0"
maxOccurs="unbounded">
        <xs:annotation>
          <xs:documentation>A representation of a single-ended
impedance requirement.</xs:documentation>
        </xs:annotation>
```

```

        <xs:complexType>
        <xs:sequence>
        <xs:element name="TraceWidth">
        <xs:annotation>
        <xs:documentation>Contains the required trace width to
use for the calculated impedance.</xs:documentation>
        </xs:annotation>
        <xs:complexType>
        <xs:attribute name="TraceWidthBottom" type="xs:double"
use="required">
        <xs:annotation>
        <xs:documentation>The etching of copper is
trapezoidal ends with the top of the copper is narrower than the bottom.
This attribute contains the width of the bottom of a trace located on the
design. For conductor layer types this value is required. The default
unit of measure is governed by StackupFile->DefaultUnits which is by
default MIL.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="TraceWidthTop" type="xs:double"
use="optional">
        <xs:annotation>
        <xs:documentation>The etching of copper is
trapezoidal ends with the top of the copper is narrower than the bottom.
This attribute contains the width of the top of a trace located on the
design. If not present then the value found in TraceWidthBottom is assume
as a starting point. The default unit of measure is governed by
StackupFile->DefaultUnits which is by default MIL.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="Units_TraceWidth" type="UnitsType"
use="optional" default="MIL">
        <xs:annotation>
        <xs:documentation>The unit value that the
TraceWidthTop and TraceWidthBottom attributes are to be measured in. </
xs:documentation>
        </xs:annotation>
        </xs:attribute>
        </xs:complexType>
        </xs:element>
        <xs:element name="RefPlane" minOccurs="0" maxOccurs="2">
        <xs:annotation>
        <xs:documentation>Contains the list of layer that
represent the reference planes used during the impedance calculation.</
xs:documentation>
        </xs:annotation>
        <xs:complexType>
        <xs:attribute name="RefLayerName" type="xs:string"
use="required">
        <xs:annotation>
        <xs:documentation>The LayerName value of the layer
found under StackupFile.SupplierData.Stackup.Group.Layer that represent a
reference plan used during the impedance calculation.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        </xs:complexType>
        </xs:element>
        </xs:sequence>

```

```
<xs:attribute name="LayerName" type="xs:string"
use="required">
  <xs:annotation>
    <xs:documentation>The Layer name used to reference the
specific Impedance Type.</xs:documentation>
  </xs:annotation>
</xs:attribute>
<xs:attribute name="Structure" type="Structure"
use="optional">
  <xs:annotation>
    <xs:documentation>Contains the impedance structure
definition in the area of stripline, microstrip or coplanar waveguided.</
xs:documentation>
  </xs:annotation>
</xs:attribute>
<xs:attribute name="ZoCalculatedOhms" type="xs:double"
use="optional">
  <xs:annotation>
    <xs:documentation>Contains the calculated single-ended
calculation result for this impedance instance.</xs:documentation>
  </xs:annotation>
</xs:attribute>
</xs:complexType>
</xs:element>
<xs:element name="Differential_Coplanar_Waveguide"
minOccurs="0" maxOccurs="unbounded">
  <xs:annotation>
    <xs:documentation>A representation of a differential
Coplanar waveguided impedance requirement.</xs:documentation>
  </xs:annotation>
<xs:complexType>
  <xs:sequence>
    <xs:element name="TraceWidth">
      <xs:annotation>
        <xs:documentation>Contains the required trace width to
use for the calculated impedance.</xs:documentation>
      </xs:annotation>
      <xs:complexType>
        <xs:attribute name="TraceWidthBottom" type="xs:double"
use="required">
          <xs:annotation>
            <xs:documentation>The etching of copper is
trapezoidal ends with the top of the copper is narrower than the bottom.
This attribute contains the width of the bottom of a trace located on the
design. For conductor layer types this value is required. The default
unit of measure is governed by StackupFile->DefaultUnits which is by
default MIL.</xs:documentation>
          </xs:annotation>
          </xs:attribute>
          <xs:attribute name="TraceWidthTop" type="xs:double"
use="optional">
            <xs:annotation>
              <xs:documentation>The etching of copper is
trapezoidal ends with the top of the copper is narrower than the bottom.
This attribute contains the width of the top of a trace located on the
design. If not present then the value found in TraceWidthBottom is assume
as a starting point. The default unit of measure is governed by
StackupFile->DefaultUnits which is by default MIL.</xs:documentation>
```

```

        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="Units_TraceWidth" type="UnitsType"
use="optional" default="MIL">
        <xs:annotation>
        <xs:documentation>The unit value that the
TraceWidthTop and TraceWidthBottom attributes are to be measured in. </
xs:documentation>
        </xs:annotation>
        </xs:attribute>
        </xs:complexType>
    </xs:element>
    <xs:element name="Spacing">
        <xs:annotation>
        <xs:documentation>Contains the required spacing between
copper for the calculated impedance.</xs:documentation>
        </xs:annotation>
        <xs:complexType>
        <xs:attribute name="Val" type="xs:double"
use="required">
        <xs:annotation>
        <xs:documentation>Contains the required spacing for
the related conductor. Default units is MIL.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="Units" type="UnitsType"
use="optional" default="MIL">
        <xs:annotation>
        <xs:documentation>Contains the unit of measure used
for by the value in Val.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        </xs:complexType>
    </xs:element>
    <xs:element name="CoplanarSpacing">
        <xs:annotation>
        <xs:documentation>Contains the coplanar desired spacing
to use for the calculated impedance.</xs:documentation>
        </xs:annotation>
        <xs:complexType>
        <xs:attribute name="Val" type="xs:double"
use="required">
        <xs:annotation>
        <xs:documentation>Contains the required coplanar
spacing of the related conductor. Default units is MIL.</
xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="Units" type="UnitsType"
use="optional" default="MIL">
        <xs:annotation>
        <xs:documentation>Contains the unit of measure used
for by the value in Val.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        </xs:complexType>
    </xs:element>
    <xs:element name="CoplanarTraceWidth" minOccurs="0">

```

```
        <xs:annotation>
        <xs:documentation>Contains the coplanar desired trace
width to use for the target impedance. In the case of reference a plane
this attribute is to not be defined.</xs:documentation>
        </xs:annotation>
        <xs:complexType>
        <xs:attribute name="TraceWidthBottom" type="xs:double"
use="required">
        <xs:annotation>
        <xs:documentation>The etching of copper is
trapezoidal ends with the top of the copper is narrower than the bottom.
This attribute contains the width of the bottom of a trace located on the
design. For conductor layer types this value is required. The default
unit of measure is governed by StackupFile->DefaultUnits which is by
default MIL.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="TraceWidthTop" type="xs:double"
use="optional">
        <xs:annotation>
        <xs:documentation>The etching of copper is
trapezoidal ends with the top of the copper is narrower than the bottom.
This attribute contains the width of the top of a trace located on the
design. If not present then the value found in TraceWidthBottom is assume
as a starting point. The default unit of measure is governed by
StackupFile->DefaultUnits which is by default MIL.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="Units_TraceWidth" type="UnitsType"
use="optional" default="MIL">
        <xs:annotation>
        <xs:documentation>The unit value that the
TraceWidthTop and TraceWidthBottom attributes are to be measured in. </
xs:documentation>
        </xs:annotation>
        </xs:attribute>
        </xs:complexType>
        </xs:element>
        <xs:element name="RefPlane" minOccurs="0" maxOccurs="2">
        <xs:annotation>
        <xs:documentation>Contains the list of layer that
represent the reference planes used during the impedance calculation.</
xs:documentation>
        </xs:annotation>
        <xs:complexType>
        <xs:attribute name="RefLayerName" type="xs:string"
use="required">
        <xs:annotation>
        <xs:documentation>The LayerName value of the layer
found under StackupFile.SupplierData.Stackup.Group.Layer that represent a
reference plan used during the impedance calculation.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        </xs:complexType>
        </xs:element>
        </xs:sequence>
        <xs:attribute name="LayerName" type="xs:string"
use="required">
```

```

        <xs:annotation>
        <xs:documentation>The Layer name used to reference the
specific Impedance Type.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="Structure" type="Structure"
use="optional">
        <xs:annotation>
        <xs:documentation>Contains the impedance structure
definition in the area of stripline, microstrip or coplanar waveguided.</
xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="ZoCalculatedOhms" type="xs:double"
use="optional">
        <xs:annotation>
        <xs:documentation>Contains the calculated single-ended
calculation result for this impedance instance.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="ZDiffCalculatedOhms" type="xs:double"
use="optional">
        <xs:annotation>
        <xs:documentation>Contains the calculated differential
calculation result for this impedance instance.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="InsertionLossUnits"
type="InsertionLossType" use="optional" default="DB/INCH">
        <xs:annotation>
        <xs:documentation>Units for InsertionLoss. Default is
dB/Inch.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="InsertionLoss" type="xs:double"
use="optional">
        <xs:annotation>
        <xs:documentation>The resulting lost of single power.</
xs:documentation>
        </xs:annotation>
        </xs:attribute>
        </xs:complexType>
        </xs:element>
        <xs:element name="Differential_Edge_Coupled" minOccurs="0"
maxOccurs="unbounded">
        <xs:annotation>
        <xs:documentation>A representation of a differential edge
coupled impedance requirement.</xs:documentation>
        </xs:annotation>
        <xs:complexType>
        <xs:sequence>
        <xs:element name="TraceWidth">
        <xs:annotation>
        <xs:documentation>Contains the required trace width to
use for the calculated impedance.</xs:documentation>
        </xs:annotation>
        <xs:complexType>
        <xs:attribute name="TraceWidthBottom" type="xs:double"

```



```
use="required">
    <xs:annotation>
        <xs:documentation>The etching of copper is
trapezoidal ends with the top of the copper is narrower than the bottom.
This attribute contains the width of the bottom of a trace located on the
design. For conductor layer types this value is required. The default
unit of measure is governed by StackupFile->DefaultUnits which is by
default MIL.</xs:documentation>
    </xs:annotation>
</xs:attribute>
<xs:attribute name="TraceWidthTop" type="xs:double"
use="optional">
    <xs:annotation>
        <xs:documentation>The etching of copper is
trapezoidal ends with the top of the copper is narrower than the bottom.
This attribute contains the width of the top of a trace located on the
design. If not present then the value found in TraceWidthBottom is assume
as a starting point. The default unit of measure is governed by
StackupFile->DefaultUnits which is by default MIL.</xs:documentation>
    </xs:annotation>
</xs:attribute>
<xs:attribute name="Units_TraceWidth" type="UnitsType"
use="optional" default="MIL">
    <xs:annotation>
        <xs:documentation>The unit value that the
TraceWidthTop and TraceWidthBottom attributes are to be measured in. </
xs:documentation>
    </xs:annotation>
</xs:attribute>
</xs:complexType>
</xs:element>
<xs:element name="Spacing">
    <xs:annotation>
        <xs:documentation>Contains the required spacing between
copper for the calculated impedance.</xs:documentation>
    </xs:annotation>
<xs:complexType>
    <xs:attribute name="Val" type="xs:double"
use="required">
        <xs:annotation>
            <xs:documentation>Contains the required spacing for
the related conductor. Default units is MIL.</xs:documentation>
        </xs:annotation>
</xs:attribute>
        <xs:attribute name="Units" type="UnitsType"
use="optional" default="MIL">
            <xs:annotation>
                <xs:documentation>Contains the unit of measure used
for by the value in Val.</xs:documentation>
            </xs:annotation>
</xs:attribute>
</xs:complexType>
</xs:element>
<xs:element name="RefPlane" minOccurs="0" maxOccurs="2">
    <xs:annotation>
        <xs:documentation>Contains the list of layer that
represent the refence planes used during the impedance calculation.</
xs:documentation>
```

```

        </xs:annotation>
        <xs:complexType>
            <xs:attribute name="RefLayerName" type="xs:string"
use="required">
                <xs:annotation>
                    <xs:documentation>The LayerName value of the layer
found under StackupFile.SupplierData.Stackup.Group.Layer that represent a
reference plan used during the impedance calculation.</xs:documentation>
                </xs:annotation>
            </xs:attribute>
        </xs:complexType>
    </xs:element>
</xs:sequence>
<xs:attribute name="LayerName" type="xs:string"
use="required">
    <xs:annotation>
        <xs:documentation>The Layer name used to reference the
specific Impedance Type.</xs:documentation>
    </xs:annotation>
</xs:attribute>
<xs:attribute name="Structure" type="Structure"
use="optional">
    <xs:annotation>
        <xs:documentation>Contains the impedance structure
definition in the area of stripline, microstrip or coplanar waveguided.</
xs:documentation>
    </xs:annotation>
</xs:attribute>
<xs:attribute name="ZoCalculatedOhms" type="xs:double"
use="optional">
    <xs:annotation>
        <xs:documentation>Contains the calculated single-ended
calculation result for this impedance instance.</xs:documentation>
    </xs:annotation>
</xs:attribute>
<xs:attribute name="ZDiffCalculatedOhms" type="xs:double"
use="optional">
    <xs:annotation>
        <xs:documentation>Contains the calculated differential
calculation result for this impedance instance.</xs:documentation>
    </xs:annotation>
</xs:attribute>
<xs:attribute name="InsertionLoss" type="xs:double"
use="optional">
    <xs:annotation>
        <xs:documentation>The resulting lost of single power.</
xs:documentation>
    </xs:annotation>
</xs:attribute>
<xs:attribute name="InsertionLossUnits"
type="InsertionLossType" use="optional" default="DB/INCH">
    <xs:annotation>
        <xs:documentation>Units for InsertionLoss. Default is
dB/Inch.</xs:documentation>
    </xs:annotation>
</xs:attribute>
</xs:complexType>
</xs:element>

```

```
<xs:element name="Single_Ended_Coplanar_Waveguide"
minOccurs="0" maxOccurs="unbounded">
  <xs:annotation>
    <xs:documentation>A representation of a single-ended
Coplanar waveguided impedance requirement.</xs:documentation>
  </xs:annotation>
  <xs:complexType>
    <xs:sequence>
      <xs:element name="TraceWidth">
        <xs:annotation>
          <xs:documentation>Contains the required trace width to
use for the calculated impedance.</xs:documentation>
        </xs:annotation>
        <xs:complexType>
          <xs:attribute name="TraceWidthBottom" type="xs:double"
use="required">
            <xs:annotation>
              <xs:documentation>The etching of copper is
trapezoidal ends with the top of the copper is narrower than the bottom.
This attribute contains the width of the bottom of a trace located on the
design. For conductor layer types this value is required. The default
unit of measure is governed by StackupFile->DefaultUnits which is by
default MIL.</xs:documentation>
            </xs:annotation>
            </xs:attribute>
            <xs:attribute name="TraceWidthTop" type="xs:double"
use="optional">
              <xs:annotation>
                <xs:documentation>The etching of copper is
trapezoidal ends with the top of the copper is narrower than the bottom.
This attribute contains the width of the top of a trace located on the
design. If not present then the value found in TraceWidthBottom is assume
as a starting point. The default unit of measure is governed by
StackupFile->DefaultUnits which is by default MIL.</xs:documentation>
              </xs:annotation>
              </xs:attribute>
              <xs:attribute name="Units_TraceWidth" type="UnitsType"
use="optional" default="MIL">
                <xs:annotation>
                  <xs:documentation>The unit value that the
TraceWidthTop and TraceWidthBottom attributes are to be measured in. </
xs:documentation>
                </xs:annotation>
                </xs:attribute>
              </xs:complexType>
            </xs:element>
            <xs:element name="CoplanarSpacing">
              <xs:annotation>
                <xs:documentation>Contains the required spacing between
copper for the calculated impedance.</xs:documentation>
              </xs:annotation>
              <xs:complexType>
                <xs:attribute name="Val" type="xs:double"
use="required">
                  <xs:annotation>
                    <xs:documentation>Contains the required spacing for
the related conductor. Default units is MIL.</xs:documentation>
                  </xs:annotation>
```

```

        </xs:attribute>
        <xs:attribute name="Units" type="UnitsType"
use="optional" default="MIL">
        <xs:annotation>
        <xs:documentation>Contains the unit of measure used
for by the value in Val.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
    </xs:complexType>
</xs:element>
<xs:element name="CoplanarTraceWidth" minOccurs="0">
    <xs:annotation>
    <xs:documentation>Contains the coplanar desired trace
width to use for the target impedance. In the case of reference a plane
this attribute is to not be defined.</xs:documentation>
    </xs:annotation>
    <xs:complexType>
    <xs:attribute name="TraceWidthBottom" type="xs:double"
use="required">
        <xs:annotation>
        <xs:documentation>The etching of copper is
trapezoidal ends with the top of the copper is narrower than the bottom.
This attribute contains the width of the bottom of a trace located on the
design. For conductor layer types this value is required. The default
unit of measure is governed by StackupFile->DefaultUnits which is by
default MIL.</xs:documentation>
        </xs:annotation>
    </xs:attribute>
    <xs:attribute name="TraceWidthTop" type="xs:double"
use="optional">
        <xs:annotation>
        <xs:documentation>The etching of copper is
trapezoidal ends with the top of the copper is narrower than the bottom.
This attribute contains the width of the top of a trace located on the
design. If not present then the value found in TraceWidthBottom is assume
as a starting point. The default unit of measure is governed by
StackupFile->DefaultUnits which is by default MIL.</xs:documentation>
        </xs:annotation>
    </xs:attribute>
    <xs:attribute name="Units_TraceWidth" type="UnitsType"
use="optional" default="MIL">
        <xs:annotation>
        <xs:documentation>The unit value that the
TraceWidthTop and TraceWidthBottom attributes are to be measured in. </
xs:documentation>
        </xs:annotation>
    </xs:attribute>
    </xs:complexType>
</xs:element>
<xs:element name="RefPlane" minOccurs="0" maxOccurs="2">
    <xs:annotation>
    <xs:documentation>Contains the list of layer that
represent the reference planes used during the impedance calculation.</
xs:documentation>
    </xs:annotation>
    <xs:complexType>
    <xs:attribute name="RefLayerName" type="xs:string"
use="required">

```

```
        <xs:annotation>
        <xs:documentation>The LayerName value of the layer
found under StackupFile.SupplierData.Stackup.Group.Layer that represent a
reference plan used during the impedance calculation.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
    </xs:complexType>
</xs:element>
</xs:sequence>
<xs:attribute name="LayerName" type="xs:string"
use="required">
    <xs:annotation>
    <xs:documentation>The Layer name used to reference the
specific Impedance Type.</xs:documentation>
    </xs:annotation>
    </xs:attribute>
    <xs:attribute name="Structure" type="Structure"
use="optional">
        <xs:annotation>
        <xs:documentation>Contains the impedance structure
definition in the area of stripline, microstrip or coplanar waveguided.</
xs:documentation>
        </xs:annotation>
        </xs:attribute>
        <xs:attribute name="ZoCalculatedOhms" type="xs:double"
use="optional">
            <xs:annotation>
            <xs:documentation>Contains the calculated single-ended
calculation result for this impedance instance.</xs:documentation>
            </xs:annotation>
            </xs:attribute>
            <xs:attribute name="ZDiffCalculatedOhms" type="xs:double"
use="optional">
                <xs:annotation>
                <xs:documentation>Contains the calculated differential
calculation result for this impedance instance.</xs:documentation>
                </xs:annotation>
                </xs:attribute>
            </xs:complexType>
        </xs:element>
        <xs:element name="Differential_Broadside_Coupled"
minOccurs="0" maxOccurs="unbounded">
            <xs:annotation>
            <xs:documentation>A representation of a differential
broadshide coupled impedance requirement.</xs:documentation>
            </xs:annotation>
            <xs:complexType>
            <xs:sequence>
                <xs:element name="TraceWidth">
                    <xs:annotation>
                    <xs:documentation>Contains the required trace width to
use for the calculated impedance.</xs:documentation>
                    </xs:annotation>
                    <xs:complexType>
                    <xs:attribute name="TraceWidthBottom" type="xs:double"
use="required">
                        <xs:annotation>
                        <xs:documentation>The etching of copper is
```

```

    trapezoidal ends with the top of the copper is narrower than the bottom.
    This attribute contains the width of the bottom of a trace located on the
    design. For conductor layer types this value is required. The default
    unit of measure is governed by StackupFile->DefaultUnits which is by
    default MIL.</xs:documentation>
    </xs:annotation>
  </xs:attribute>
  <xs:attribute name="TraceWidthTop" type="xs:double"
use="optional">
    <xs:annotation>
      <xs:documentation>The etching of copper is
    trapezoidal ends with the top of the copper is narrower than the bottom.
    This attribute contains the width of the top of a trace located on the
    design. If not present then the value found in TraceWidthBottom is assume
    as a starting point. The default unit of measure is governed by
    StackupFile->DefaultUnits which is by default MIL.</xs:documentation>
    </xs:annotation>
  </xs:attribute>
  <xs:attribute name="Units_TraceWidth" type="UnitsType"
use="optional" default="MIL">
    <xs:annotation>
      <xs:documentation>The unit value that the
    TraceWidthTop and TraceWidthBottom attributes are to be measured in. </
    xs:documentation>
    </xs:annotation>
  </xs:attribute>
</xs:complexType>
</xs:element>
<xs:element name="TraceSeparation">
  <xs:annotation>
    <xs:documentation>Contains the required distance
    between the related conductors.</xs:documentation>
  </xs:annotation>
  <xs:complexType>
    <xs:attribute name="Val" type="xs:double"
use="required">
      <xs:annotation>
        <xs:documentation>Contains the required separation
        between of the related conductor. Default units is MIL.</
        xs:documentation>
        </xs:annotation>
      </xs:attribute>
      <xs:attribute name="Units" type="UnitsType"
use="optional" default="MIL">
        <xs:annotation>
          <xs:documentation>Contains the unit of measure used
          for by the value in Val.</xs:documentation>
        </xs:annotation>
      </xs:attribute>
      <xs:attribute name="IsPitch" type="xs:boolean"
use="optional" default="false">
        <xs:annotation>
          <xs:documentation>Trace Separation definitiion - if
          true the spacing between the conductors are measured from center line to
          center line or pitch, if false a value for the spacing is edge to edge of
          the conductors.</xs:documentation>
        </xs:annotation>
      </xs:attribute>
    </xs:complexType>
  </xs:element>

```

```
        </xs:complexType>
      </xs:element>
    <xs:element name="RefPlane" minOccurs="0" maxOccurs="2">
      <xs:annotation>
        <xs:documentation>Contains the list of layer that
represent the reference planes used during the impedance calculation.</
xs:documentation>
      </xs:annotation>
      <xs:complexType>
        <xs:attribute name="RefLayerName" type="xs:string"
use="required">
          <xs:annotation>
            <xs:documentation>The LayerName value of the layer
found under StackupFile.SupplierData.Stackup.Group.Layer that represent a
reference plan used during the impedance calculation.</xs:documentation>
          </xs:annotation>
        </xs:attribute>
      </xs:complexType>
    </xs:element>
  </xs:sequence>
  <xs:attribute name="LayerName" type="xs:string"
use="required">
    <xs:annotation>
      <xs:documentation>The Layer name used to reference the
specific Impedance Type.</xs:documentation>
    </xs:annotation>
  </xs:attribute>
  <xs:attribute name="Structure" type="Structure"
use="optional">
    <xs:annotation>
      <xs:documentation>Contains the impedance structure
definition in the area of stripline, microstrip or coplanar waveguided.</
xs:documentation>
    </xs:annotation>
  </xs:attribute>
  <xs:attribute name="ZoCalculatedOhms" type="xs:double"
use="optional">
    <xs:annotation>
      <xs:documentation>Contains the calculated single-ended
calculation result for this impedance instance.</xs:documentation>
    </xs:annotation>
  </xs:attribute>
  <xs:attribute name="ZDiffCalculatedOhms" type="xs:double"
use="optional">
    <xs:annotation>
      <xs:documentation>Contains the calculated differential
calculation result for this impedance instance.</xs:documentation>
    </xs:annotation>
  </xs:attribute>
  <xs:attribute name="InsertionLoss" type="xs:double"
use="optional">
    <xs:annotation>
      <xs:documentation>The resulting lost of single power.</
xs:documentation>
    </xs:annotation>
  </xs:attribute>
  <xs:attribute name="InsertionLossUnits"
type="InsertionLossType" use="optional" default="DB/INCH">
```

```

        <xs:annotation>
        <xs:documentation>Units for InsertionLoss. Default is
dB/Inch.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        </xs:complexType>
        </xs:element>
    </xs:sequence>
    <xs:attribute name="ImpName" type="xs:string"
use="required">
        <xs:annotation>
        <xs:documentation>The name used to reference the specific
Impedance.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        </xs:complexType>
        </xs:element>
    </xs:sequence>
    <xs:attribute name="SpecName" type="xs:string" use="required">
        <xs:annotation>
        <xs:documentation>The name used to reference the specific
Spec.</xs:documentation>
        </xs:annotation>
        </xs:attribute>
        </xs:complexType>
        </xs:element>
    </xs:sequence>
    </xs:complexType>
</xs:element>
<xs:element name="Stackup">
    <xs:annotation>
    <xs:documentation>Contains the manufacturing stackup
representation determined by the supplier.</xs:documentation>
    </xs:annotation>
    <xs:complexType>
    <xs:sequence>
    <xs:element name="Group" maxOccurs="unbounded">
        <xs:annotation>
        <xs:documentation>A stackup is created by mutliple Group which
is comprised of a collection of Materials with condutor materials tied to
copper layers of the design. The series is represented from the top of
the design to the bottom.</xs:documentation>
        </xs:annotation>
        <xs:complexType>
        <xs:sequence>
        <xs:element name="Layer" maxOccurs="unbounded">
            <xs:annotation>
            <xs:documentation>A layer definition within the Group.</
xs:documentation>
            </xs:annotation>
            <xs:complexType>
            <xs:sequence>
            <xs:element name="SpecRef" minOccurs="0">
                <xs:annotation>
                <xs:documentation>The list Material and Impedance Specs
and conductor requirements for a layer.</xs:documentation>
                </xs:annotation>
                <xs:complexType>

```



```
<xs:sequence>
  <xs:element name="Material" minOccurs="0">
    <xs:annotation>
      <xs:documentation>Defines the Material requirements
for a layer.</xs:documentation>
    </xs:annotation>
    <xs:complexType>
      <xs:attribute name="MaterialName" type="xs:string"
use="required">
        <xs:annotation>
          <xs:documentation>The name used for referencing the
designated Material within the referenced SpecName.</xs:documentation>
        </xs:annotation>
      </xs:attribute>
      <xs:attribute name="PropertyName" type="xs:string"
use="optional">
        <xs:annotation>
          <xs:documentation>The name used for referencing the
designated Properties within the referenced Material. If there is only
one Property defined then that will be considered the default and the
existence of the attribute FrequencyVal not required.</xs:documentation>
        </xs:annotation>
      </xs:attribute>
      <xs:attribute name="FrequencyVal" type="xs:double"
use="optional">
        <xs:annotation>
          <xs:documentation>Contains the frequency of the
signal on the net. Could be used to reference additional material content
when used as a reference into FrequencyName. If there is only one
Frequency defined then that will be considered the default and the
existence of the attribute is not required.</xs:documentation>
        </xs:annotation>
      </xs:attribute>
      <xs:attribute name="CopperAreaPercent"
type="xs:double" use="optional">
        <xs:annotation>
          <xs:documentation>A percentage calculated by finding
the copper area of a layer and dividing that by the total area of layer
laminiate.</xs:documentation>
        </xs:annotation>
      </xs:attribute>
    </xs:complexType>
  </xs:element>
</xs:sequence>
  <xs:attribute name="MaterialSpecName" type="xs:string"
use="required">
    <xs:annotation>
      <xs:documentation>The name used for referencing the
selected Material Spec.</xs:documentation>
    </xs:annotation>
  </xs:attribute>
  <xs:attribute name="ImpSpecName" type="xs:string"
use="optional">
    <xs:annotation>
      <xs:documentation>The name used for referencing the
selected Impedance Spec.</xs:documentation>
    </xs:annotation>
  </xs:attribute>
```

```

        </xs:complexType>
    </xs:element>
</xs:sequence>
<xs:attribute name="LayerName" type="xs:string"
use="required">
    <xs:annotation>
        <xs:documentation>A name of layer that in most case found
within the EdaData.Stackup.Group.Layer section. If the following Layer
attributes are missing they are taken from that reference. Otherwise they
may need to be added.</xs:documentation>
    </xs:annotation>
    </xs:attribute>
    <xs:attribute name="LayerType" type="LayerType"
use="optional" default="DOCUMENT">
    <xs:annotation>
        <xs:documentation>An enumerated list of layer type
representing the purpose behind the layer. Default is DOCUMENT.</
xs:documentation>
    </xs:annotation>
    </xs:attribute>
    <xs:attribute name="LayerSubType" type="LayerSubType"
use="optional">
    <xs:annotation>
        <xs:documentation>An enumerated list of sub layer type
when used to further refine the meaning behind the value found it
LayerType. For example, a LayerType DRILL with a SubType BACKDRILL.</
xs:documentation>
    </xs:annotation>
    </xs:attribute>
    <xs:attribute name="MechStartLayerName" type="xs:string"
use="optional">
    <xs:annotation>
        <xs:documentation>In the event LayerType has the value of
DRILL or ROUT, this attribute value represents the beginning layer named
where the material in mechanically penetrated.</xs:documentation>
    </xs:annotation>
    </xs:attribute>
    <xs:attribute name="MechEndLayerName" type="xs:string"
use="optional">
    <xs:annotation>
        <xs:documentation>In the event LayerType has the value of
DRILL or ROUT, this attribute value represents the final layer named where
the material in mechanically penetrated.</xs:documentation>
    </xs:annotation>
    </xs:attribute>
    <xs:attribute name="Side" type="SideType" use="optional"
default="NONE">
    <xs:annotation>
        <xs:documentation>An enumerated list of a value declaring
the relative position of the layer within the stackup. Default is NONE.</
xs:documentation>
    </xs:annotation>
    </xs:attribute>
    <xs:attribute name="Description" type="xs:string"
use="optional">
    <xs:annotation>
        <xs:documentation>Open description from the supplier of
the Layer.</xs:documentation>

```

```
        </xs:annotation>
      </xs:attribute>
      <xs:attribute name="Comment" type="xs:string"
use="optional">
        <xs:annotation>
          <xs:documentation>Open comment from the supplier of the
Layer.</xs:documentation>
        </xs:annotation>
      </xs:attribute>
    </xs:complexType>
  </xs:element>
</xs:sequence>
  <xs:attribute name="GroupName" type="xs:string" use="required">
    <xs:annotation>
      <xs:documentation>The name used to reference the Group.</
xs:documentation>
    </xs:annotation>
  </xs:attribute>
  <xs:attribute name="GroupThickness" type="xs:double"
use="optional">
    <xs:annotation>
      <xs:documentation>The total thickness for the group of
layers. Default unit is MIL.</xs:documentation>
    </xs:annotation>
  </xs:attribute>
  <xs:attribute name="Units" type="UnitsType" use="optional"
default="MIL">
    <xs:annotation>
      <xs:documentation>The unit value that the GroupThickness
attribute are to be measured in. The default unit of measure is governed
by StackupFile->DefaultUnits which is by default MIL.</xs:documentation>
    </xs:annotation>
  </xs:attribute>
  <xs:attribute name="NumberOfLaminateCycles" type="xs:integer"
use="optional">
    <xs:annotation>
      <xs:documentation>Total number of lamination cycles the group
of layers will be subjected to from the beginning to the end of the
booking process.</xs:documentation>
    </xs:annotation>
  </xs:attribute>
</xs:complexType>
</xs:element>
</xs:sequence>
  <xs:attribute name="StackupName" type="xs:string" use="required">
    <xs:annotation>
      <xs:documentation>The name used to reference the Stackup.</
xs:documentation>
    </xs:annotation>
  </xs:attribute>
  <xs:attribute name="StackupThickness" type="xs:double"
use="required">
    <xs:annotation>
      <xs:documentation>The calculated board thickness. Default unit
is MIL.</xs:documentation>
    </xs:annotation>
  </xs:attribute>
  <xs:attribute name="Status" type="StackupStatus" use="optional"
```

```
default="SUBMITTED">
  <xs:annotation>
    <xs:documentation>A stackup as one of five values, SELECTED
indicates the stackup the fabricator should build from, VALID indicates
the a design team has determine the stackup would meet the needs, INVALID
indicate that somewhere a team determined the stackup was not to be used
for any reason, SUBMITTED is the default state which means the stackup has
not yet been validated for use and UNDER REVIEW indicates that stackup is
being reviewed for use.</xs:documentation>
  </xs:annotation>
</xs:attribute>
  <xs:attribute name="Units" type="UnitsType" use="optional"
default="MIL">
  <xs:annotation>
    <xs:documentation>The unit value that the StackupThickness
attribute are to be measured in. The default unit of measure is governed
by StackupFile->DefaultUnits which is by default MIL.</xs:documentation>
  </xs:annotation>
</xs:attribute>
  <xs:attribute name="WhereMeasured" type="WhereMeasured"
use="optional" default="METAL">
  <xs:annotation>
    <xs:documentation>An enumerated value of where the
StackupThickness is measuared from.</xs:documentation>
  </xs:annotation>
</xs:attribute>
  <xs:attribute name="TotalLaminationCycles" type="xs:integer"
use="optional">
  <xs:annotation>
    <xs:documentation>Total number of lamination cycles required to
complete the booking process.</xs:documentation>
  </xs:annotation>
</xs:attribute>
</xs:complexType>
</xs:element>
</xs:sequence>
  <xs:attribute name="CompanyName" use="required">
  <xs:annotation>
    <xs:documentation>The name of the supplier defining the
manufacturing stackup.</xs:documentation>
  </xs:annotation>
</xs:attribute>
  <xs:attribute name="ContactName" type="xs:string">
  <xs:annotation>
    <xs:documentation>The name of the contact of the supplier
stackup.</xs:documentation>
  </xs:annotation>
</xs:attribute>
  <xs:attribute name="Address" type="xs:string">
  <xs:annotation>
    <xs:documentation>The postal address of the supplier of the
manufacturing stackup.</xs:documentation>
  </xs:annotation>
</xs:attribute>
  <xs:attribute name="PhoneNumber" type="xs:string">
  <xs:annotation>
    <xs:documentation>The phone number of the supplier of the
manaufacturing stackup.</xs:documentation>
```

```
        </xs:annotation>
      </xs:attribute>
      <xs:attribute name="Comment" type="xs:string">
        <xs:annotation>
          <xs:documentation>Open comment from the supplier of the
manufacturing stackup.</xs:documentation>
        </xs:annotation>
      </xs:attribute>
    </xs:complexType>
  </xs:element>
</xs:sequence>
<xs:attribute name="Version" type="xs:string" use="required">
  <xs:annotation>
    <xs:documentation>Defines the ODB++ Version of the stackup.xml
file.</xs:documentation>
  </xs:annotation>
</xs:attribute>
<xs:attribute name="DefaultUnits" type="UnitsType" use="optional"
default="MIL">
  <xs:annotation>
    <xs:documentation>The DefaultUnits carries the dimension Units value
whenever referenced by the schema. The default UNITS are MIL, but that
could be changed by assigning this attribute value to another unit.</
xs:documentation>
  </xs:annotation>
</xs:attribute>
</xs:complexType>
</xs:element>
</xs:schema>
```


Appendix F

Impedance Schema

This appendix describes the elements, their related sub-elements, and the relevant attributes of the impedance file. Each element's description contains the following sections: parent element, hierarchical diagram, minimum and maximum numbers of occurrences, description of the attributes, and a list of sub-elements known as children. The full schema file is provided.

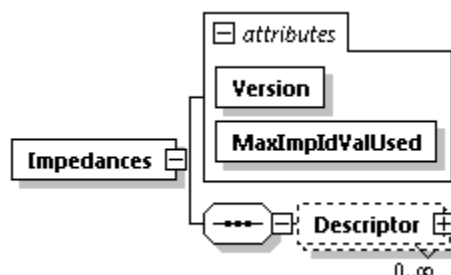
Elements or attributes enclosed in solid lines are mandatory. Those enclosed in dotted lines are optional. Plus or minus indicate the collapsed or expanded state of the element or attribute. The display of a numerical range under an element or attribute indicates its accepted range of values. Some elements are designated as `simpleType`—they specify constraints and information about the values of attributes or text-only elements. Other elements are `complexType`—an XML element that contains other elements or attributes.

Impedances	512
Impedances/Descriptor	513
Impedances/Descriptor/RequiredImpedance	515
Impedances/Descriptor/OriginalTraceWidth	517
Impedances/Descriptor/OriginalSpacing	518
Impedances/Descriptor/RefPlane	519
Impedance Schema File	519

Impedances

The base of the Impedance content for the step.

Diagram



Attributes

Name	Type	Use	Default	Description
Version	xs:string	required		Defines the ODB++ Version of the <i>impedance.xml</i> file
MaxImpIdVal Used	xs:integer	required		Contains the largest Impedance - > Descriptor -> id value ever used. Eliminates the need of reuse if an Impedance -> Descriptor is deleted.

Children

[“Impedances/Descriptor”](#) on page 513

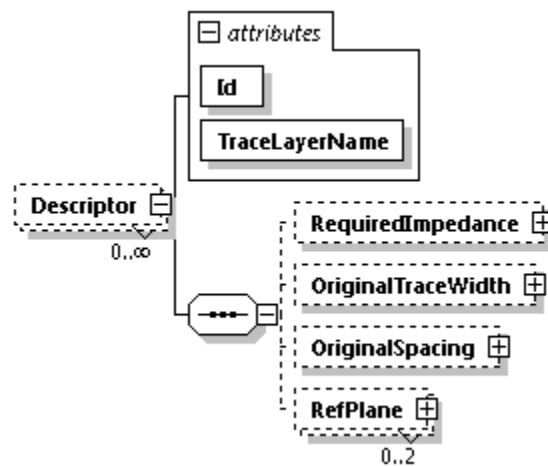
Impedances/Descriptor

A list of impedance requirements for the trace features that bear the id attribute and reside in the layer having a specific name.

Parent

“[Impedances](#)” on page 512

Diagram



Occurrence

0-n

Attributes

Name	Type	Use	Default	Description
id	xs:integer	required		A unique ID assigned to line features that use the .imp_constraint_id system attribute
TraceLayerName	xs:string	required		The name of the layer containing the traces to which the id attribute is assigned

Children

- “[Impedances/Descriptor/RequiredImpedance](#)” on page 515

- “[Impedances/Descriptor/OriginalTraceWidth](#)” on page 517
- “[Impedances/Descriptor/OriginalSpacing](#)” on page 518
- “[Impedances/Descriptor/RefPlane](#)” on page 519

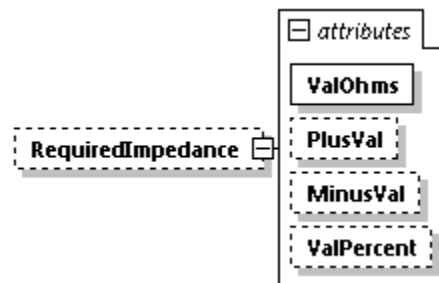
Impedances/Descriptor/RequiredImpedance

The required impedance values.

Parent

“[Impedances/Descriptor](#)” on page 513

Diagram



Occurrence

0-1

Attributes

Name	Type	Use	Default	Description
ValOhms	xs:double	required		Target impedance value in Ohms
PlusVal	xs:double	optional		A positive value representing the plus value to add to the target impedance value ValOhms (tolerance). The use of this attribute is determined by the value of the ValPercent attribute.
MinusVal	xs:double	optional		A positive value representing the plus value to subtract from the target impedance value ValOhms (tolerance). The use of this attribute is determined by the value of the ValPercent attribute.

Name	Type	Use	Default	Description
ValPercent	xs:boolean	optional	true	Impedance tolerance definition: true — a percentage of the ValOhms value false — an absolute value to add or subtract from the ValOhms value

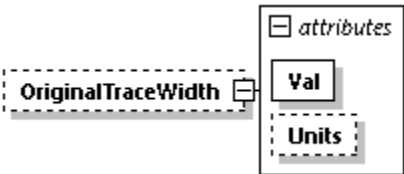
Impedances/Descriptor/OriginalTraceWidth

Contains the original trace width for the required impedance.

Parent

“[Impedances/Descriptor](#)” on page 513

Diagram



Occurrence

0-1

Attributes

Name	Type	Use	Default	Description
Val	xs:double	required		The original trace width of the feature
Units	UnitsType	optional	MIL	The unit of measure used by the Val attribute

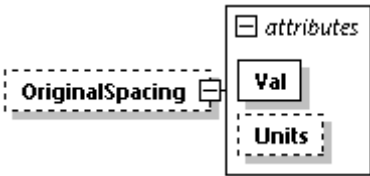
Impedances/Descriptor/OriginalSpacing

Contains the original spacing between copper for the required impedance.

Parent

“[Impedances/Descriptor](#)” on page 513

Diagram



Occurrence

0-1

Attributes

Name	Type	Use	Default	Description
Val	xs:double	required		The original spacing between features
Units	UnitsType	optional	MIL	The unit of measure used by the Val attribute

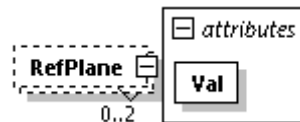
Impedances/Descriptor/RefPlane

Contains the list of layers that represent the reference planes in impedance calculation.

Parent

“[Impedances/Descriptor](#)” on page 513

Diagram



Occurrence

0-2

Attributes

Name	Type	Use	Default	Description
Val	xs:integer	required		The ODB++ ID value of the layer found under Matrix -> Layers -> Layer -> Id that represents a reference plane in impedance calculation.

Impedance Schema File

This is the full schema file.

```
<?xml version="1.0" encoding="Windows-1252"?>
<!-- edited with XMLSpy v2020 sp1 (x64) (http://www.altova.com) by Nina
Kaluta (Mentor Graphics) -->
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
elementFormDefault="qualified" attributeFormDefault="unqualified">
  <xs:simpleType name="UnitsType">
    <xs:restriction base="xs:string">
      <xs:enumeration value="MM"/>
      <xs:enumeration value="MICRON"/>
      <xs:enumeration value="INCH"/>
      <xs:enumeration value="MIL"/>
    </xs:restriction>
  </xs:simpleType>
  <xs:element name="Impedances">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="Descriptor" minOccurs="0" maxOccurs="unbounded">
          <xs:annotation>
            <xs:documentation>A list of Impedance requirement that are to be
assign to trace features on the associated layer by name.</
xs:documentation>
          </xs:annotation>
        <xs:complexType>
          <xs:sequence>
            <xs:element name="RequiredImpedance" minOccurs="0">
              <xs:annotation>
                <xs:documentation>The required impedance values.</
xs:documentation>
              </xs:annotation>
            <xs:complexType>
              <xs:attribute name="ValOhms" type="xs:double" use="required">
                <xs:annotation>
                  <xs:documentation>Impedance target value in Ohms.</
xs:documentation>
                </xs:annotation>
              </xs:attribute>
              <xs:attribute name="PlusVal" type="xs:double" use="optional">
                <xs:annotation>
                  <xs:documentation>A positive value representing the plus value
to add to the target impedance value ValOhms. (tolerance). Use of PlusVal
determined by the ValPercent value.</xs:documentation>
                </xs:annotation>
              </xs:attribute>
              <xs:attribute name="MinusVal" type="xs:double" use="optional">
                <xs:annotation>
                  <xs:documentation>A positive value representing the plus value
to subtract from the target impedance value ValOhms. (tolerance). Use of
MinusVal determined by the ValPercent value.</xs:documentation>
                </xs:annotation>
              </xs:attribute>
              <xs:attribute name="ValPercent" type="xs:boolean" use="optional"
default="true">
                <xs:annotation>
                  <xs:documentation>Impedance tolerance definition - if true a
percentage of ValOhms, if false an absolute a value to add or subtract
from ValOhms.</xs:documentation>
                </xs:annotation>
              </xs:attribute>
            </xs:sequence>
          </xs:complexType>
        </xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
</xs:schema>
```



```

        </xs:complexType>
    </xs:element>
    <xs:element name="OriginalTraceWidth" minOccurs="0">
        <xs:annotation>
            <xs:documentation>Contains the original trace width to use for the
required impedance.</xs:documentation>
        </xs:annotation>
        <xs:complexType>
            <xs:attribute name="Val" type="xs:double" use="required">
                <xs:annotation>
                    <xs:documentation>The original trace width of the feature.
Default unit is MIL.</xs:documentation>
                </xs:annotation>
            </xs:attribute>
            <xs:attribute name="Units" type="UnitsType" use="optional"
default="MIL">
                <xs:annotation>
                    <xs:documentation>Contains the unit of measure used for by the
value in Val.</xs:documentation>
                </xs:annotation>
            </xs:attribute>
        </xs:complexType>
    </xs:element>
    <xs:element name="OriginalSpacing" minOccurs="0">
        <xs:annotation>
            <xs:documentation>Contains the original spacing between copper for
the required impedance.</xs:documentation>
        </xs:annotation>
        <xs:complexType>
            <xs:attribute name="Val" type="xs:double" use="required">
                <xs:annotation>
                    <xs:documentation>The original spacing of the features. Default
unit is MIL.</xs:documentation>
                </xs:annotation>
            </xs:attribute>
            <xs:attribute name="Units" type="UnitsType" use="optional"
default="MIL">
                <xs:annotation>
                    <xs:documentation>Contains the unit of measure used for by the
value in Val.</xs:documentation>
                </xs:annotation>
            </xs:attribute>
        </xs:complexType>
    </xs:element>
    <xs:element name="RefPlane" minOccurs="0" maxOccurs="2">
        <xs:annotation>
            <xs:documentation>Contains the list of layer that represent the
reference plane used during the impedance calculation.</xs:documentation>
        </xs:annotation>
        <xs:complexType>
            <xs:attribute name="Val" type="xs:integer" use="required">
                <xs:annotation>
                    <xs:documentation>The ODB++ ID value of the layer found under
Matrix.Layers.Layer.Id that represent a reference plane used during the
impedance calculation.</xs:documentation>
                </xs:annotation>
            </xs:attribute>
        </xs:complexType>
    </xs:element>

```

```
        </xs:element>
      </xs:sequence>
      <xs:attribute name="Id" type="xs:integer" use="required">
        <xs:annotation>
          <xs:documentation>The unique Id to be assigned to line features
using the .imp_constraint_id system attribute.</xs:documentation>
        </xs:annotation>
      </xs:attribute>
      <xs:attribute name="TraceLayerName" type="xs:string" use="required">
        <xs:annotation>
          <xs:documentation>The name of the layer containing the traces
assign reside.</xs:documentation>
        </xs:annotation>
      </xs:attribute>
    </xs:complexType>
  </xs:element>
</xs:sequence>
  <xs:attribute name="Version" type="xs:string" use="required">
    <xs:annotation>
      <xs:documentation>Defines the ODB++ Version of the impedance.xml
file.</xs:documentation>
    </xs:annotation>
  </xs:attribute>
  <xs:attribute name="MaxImpIdValUsed" type="xs:integer" use="required">
    <xs:annotation>
      <xs:documentation>Contains the largest Impedance.Descriptor.id value
ever used. Used to eliminate the possibility of reuse in the event a
Impedances.Descriptor is deleted.</xs:documentation>
    </xs:annotation>
  </xs:attribute>
</xs:complexType>
</xs:element>
</xs:schema>
```

Appendix G

XML SimpleType Elements

This appendix provides information on the SimpleType elements that specify constraints and information about attribute values in the XML files within the ODB++ directory structure.

Enumerations 523

Enumerations

The enumerations used by XML attributes.

Polarity

Controls whether the graphic representation of features is to be considered to be solid.

Options

- **POSITIVE** — For layers of type SIGNAL, POWER_GROUND, and MIXED, the features represent copper; for layers of type SOLDER_PASTE, features represent paste.

Layers of type COMPONENT, SILKSCREEN, DRILL, ROUT, and DOCUMENTATION should always have POSITIVE polarity. This polarity value in the matrix is in no way connected to the intended artwork generation polarity.

Exception: In layers of type SOLDER_MASK and MASK, the features represent clearances in the physical mask, while polarity must be POSITIVE.

- **NEGATIVE** — The features represent laminate. This is most commonly used on layers of type POWER_GROUND where pad features represent clearance, and background content is copper.

LayerType

An enumerated list of layer types representing the purpose of the layer.

Options

- **SIGNAL** — A layer used for regular signal transfer
- **POWER_GROUND** — A plane layer, used for power or ground signals
- **MIXED** — A combination of a signal and a plane layer
- **SOLDER_MASK** — A layer used for solder mask application

- **SILK_SCREEN** — A layer used for application of text legend
- **SOLDER_PASTE** — A layer used for depositing solder paste for assembly
- **DRILL** — A layer used to produce drill programs
- **ROUT** — A layer used to produce rout program
- **DOCUMENT** — A layer used for drawings, testing, auxiliary processes, and so forth (default)
- **MASK** — A layer containing additional information used as the base type for all mask types
- **DIELECTRIC** — A dielectric layer that separates two copper layers
- **CONDUCTIVE_PASTE** — A layer used to represent the depositing of conductive materials.
- **COMPONENT** — A layer containing components locations and outlines
- **POWER** — A copper layer that carries the voltage of the PCB
- **GROUND** — A copper layer connected to the ground

LayerSubType

An enumerated list of layer subtypes that refine the LayerType value. For example, a LayerType DRILL with a SubType BACKDRILL.

Options

Values available when LayerType=DIELECTRIC:

- **CORE** — Material that is pre-pressed layers according to a pattern of copper foil - prepreg - copper foil.
- **PREPREG** — Material that is constructed with fiberglass impregnated with resin. The resin is pre-dried, but not hardened, and when heated, flows to adhere to neighboring material.

For values available for other base layer types, see corresponding tables in “[Layer Subtypes](#)” on page 70.

Context

The context of layer.

Options

- **BOARD** — A layer that participates in the actual board production.
- **MISC** — Any other layer that is used for drawings, testing, and so forth.

SideType

An enumerated list of a values declaring the relative position of the layer within the stackup.

Options

- NONE (default)
- TOP
- BOTTOM
- INNER

UnitsType

The units of measure.

Options

- MM
- MICRON
- INCH
- MIL (default)

WhereMeasured

An enumerated value indicating where to measure the StackupThickness value.

Options

- LAMINATE
- METAL
- MASK
- OTHER

Structure

The impedance structure definition for the stripline, microstrip, or Coplanar waveguide areas.

Options

- STRIPLINE
- PLANE_LESS_STRIPLINE
- MICROSTRIP_EMBEDDED
- MICROSTRIP_NO_MASK

- MICROSTRIP_MASK_COVERED
- COPLANAR_WAVEGUIDED_STRIPLINE
- COPLANAR_WAVEGUIDED_NO_MASK
- OPLANAR_WAVEGUIDED_MASK_COVERED

DielectricType

The generic type of dielectric materials.

Options

- PREPREG
- CORE
- OTHER
- UNDEFINED

ConductorType

The type of conductor.

Options

- COPPER
- OTHER

FrequencyType

The unit of the FrequencyVal attribute.

Options

- Hz
- MHz
- GHz

OtherType

A list of material definitions that are most often used when DielectricType=OTHER.

Options

- COVERLAY
- COVERCOAT
- STIFFENER

- PRESSURE_SENSITIVE_ADHESIVE
- OSP_MASK
- SILVER_MASK
- CARBON_MASK
- SOLDER_MASK
- PLATING_MASK
- IMMERSION_MASK
- OTHER

ImpedanceType

The type of impedance to use within the designated Impedance.

Options

- SINGLE_ENDED
- DIFFERENTIAL_COPLANAR_WAVEGUIDED
- DIFFERENTIAL_EDGE_COUPLE
- SINGLE_ENDED_COPLANAR_WAVEGUIDED
- DIFFERENTIAL_BROADSIDE_COUPLED

InsertionLossType

Units for InsertionLoss.

Options

- DB/INCH (default)
- DB/CM
- DB/M

StackupStatus

The stackup status as one of the following values:

Options

- **SELECTED** — The stackup is selected for use by the fabricator.
- **VALID** — The stackup meets the needs of the design team.
- **INVALID** — The stackup does not meet the needs of the design team.

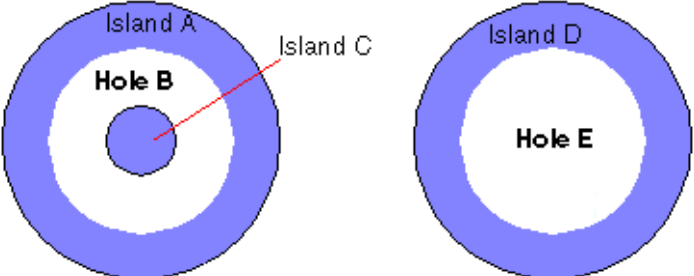
- **SUBMITTED** — The stackup has not been validated for use (default).
- **UNDER REVIEW** — The stackup is being reviewed for use.

Appendix H

Frequently Asked Questions

These are some frequently asked questions.

Question	Reply
Why is ODB++ data in ASCII?	ASCII data provides numerous advantages: <ul style="list-style-type: none">• It is easy to read and understand.• Translators to and from the data formats are easier to write.• The data is portable between different architectures, independent of byte order, floating point formats, and so forth.• By compressing the ASCII files using standard compress commands, the size is smaller than the binary equivalent, because the compression algorithm is adaptive and works well when strings are repeated.
To rotate a feature pad by 90 degrees, in what direction is the aperture rotated?	Clockwise.
Do any of these symbols have negative components: donuts, butterflies, thermals, and moires?	Standard symbols are all positive. Holes in symbols are see-through by definition.
When the start-point and end-point of a feature coincide, is this considered a 360-degree arc or a single point?	A 360-degree arc; there are no single point arcs in the ODB++ format.
Can I draw an arc with a square symbol?	Arcs can be drawn only with a round symbol.
When I specify an x, y location for text, where will the text string be located?	The version parameter for text records controls text placement. See “T — Text Records” on page 180.
What is the meaning of the optimize field in a netlist file?	It indicates that the net has been optimized and the end-point markers have been removed from mid-points.
In a netlist file, how should the radius field be set for drills of 0.002 inches through non-SMDs?	The radius field will be 0.001 mils in this case.
In a netlist file, what are staggered points?	These are points that have been staggered to make them accessible to test probes.

Question	Reply
Can feature files of user-defined symbols contain references to other user-defined symbols?	Yes, they can. But recursion, direct or indirect is not allowed.
Regarding surfaces, is there a particular order in specifying holes and islands?	<p>The order of containment must be preserved. Islands precede holes that are contained in them. Holes precede islands that are contained in them. Consider this containment</p>  <p>order:</p>
Regarding surfaces, does the outermost island come first?	Yes.
Regarding rounded or chamfered rectangles, how do I specify corners?	See “ Rounded/Chamfered Rectangles ” on page 212.
<p>To offset a rectangular pad in X or Y, should I use a standard symbol and use the standard ODB++ to create the offset?</p> <p>Is this the correct feature file for a rect pad 70x50 with an X offset of 5?</p> <pre># # Symbol name # \$0 rect70x50 # # Pad definition # P .005 .0 0 P 0 0</pre>	<p>Instead of defining your own symbols with offsets, you should use the standard rect symbol, and offset the coordinate that references it, in the layer features file.</p>
<p>Is there a list of recognized properties (PRP) on components (such as with system attributes)?</p> <p>And for PRP in the <i>eda/data</i> file.</p>	There is no list of predefined properties in the ODB++ format. These are EDA-specific.
When defining a PKG record (using /steps/step_name/eda/data), it seems that ODB++ expects closed geometries. Is it critical to have only closed elements?	Yes, you must close all polygons.

Question	Reply
What is the correct order for the matrix layers?	<p>This is the recommended sequence:</p> <ul style="list-style-type: none"> • Top component, solderpaste, silkscreen, soldermask. • Copper layers in their order. • Soldermask, silkscreen, solderpaste, bottom component. • Drill layers in sequence from where the drills started, to the largest depth (largest to smallest), then layer 2 to the largest depth, and so forth. • Rout layers. • Document and misc layers.
How are the net_num records numbered?	The net_num used in the top record corresponds to the sequence of the net records in the <i>eda/data</i> file. The first net record is net_num 0, the second is net_num 1, and so on.
We have an elaborate tool set to define routing slots and milling contours. How is this data written to ODB++?	Milling (referred to as routing in fabrication, and not to be confused with routing of traces in design) is handled by defining a rout layer (similar to a drill layer). The features in this layer correspond to the outline of the shapes that need to be cut out. A rout layer is like any other layer, but for it to be used during fabrication, should contain only lines, arcs and circular pads (rout machines can also drill).
What net do I assign to points that have no net defined?	Features that do not have a net defined should be assigned to net \$NONE\$, which should be defined in the <i>eda/data</i> file. You must add the net and all points to the <i>cadnet</i> file.
What is the maximum line length in an ODB++ file?	The restrictions are different for different files. In general 1,400 characters is the limit, but there are exceptions. Any line over the defined limit will be read with the remainder of the line ignored, so comments can be longer than the limit.

